TAXONOMY OF PREDATORY COCCINELLID BEETLES (COCCINELLIDAE: COLEOPTERA) IN RICE AND VEGETABLES

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THESIS

Submitted in partial fulfilment of the requirement for the degree of

Master of Science in Agriculture

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2003

DECLARATION

I hereby declare that this thesis entitled **"Taxonomy of predatory Coccinellid beetles (Coccinellidae: Coleoptera) in rice and vegetables"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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CERTIFICATE

Certified that this thesis entitled **"Taxonomy of predatory Coccinellid beetles (Coccinellidae: Coleoptera) in rice and vegetables"** is a record of work done independently by **Kum. Queno Jose**, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

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ACKNOWLEDGEMENT

I wish to express my heartful gratitude to ***Dr.Haseena Bhaskar,*** *Assistant Professor, Department of Agricultural Entomology and Chairperson of the advisory committee for all the help and moral support rendered by her through out the course of investigation.*

I express my deep sense of gratitude to ***Dr.Jim Thomas,*** *Associate Professor and Head, Department of Agricultural Entomology, College of Horticulture, Vellanikkara for providing me all facilities in the department for the conduct of research and his valuable instructions and suggestions.*

I am very much indebted to ***Dr.Maicykutty P. Mathew,*** *Associate Professor, Department of Agricultural Entomology, College of Horticulture, for her constant guidance all through the study and critical suggestions provided for the preparation of thsis.*

I am grateful to ***Dr.V.K.G. Unnithan,*** *Associate Professor and Head, Department of Agricultural Statistics, College of Horticulture, for his guidance during the course of study.*

My heartfelt thanks are due to Dr.A.M.Ranjith, Associate Professor, Department of Entomology, for the help rendered in making good quality photographs and valuable comments on the conduct of research.

It is a pleasure to keep in mind the affectionate help and constant encouragement rendered by Dr.Sosamma Jacob, Dr.Vshakumari, Dr.Lyla, K.R. and Dr.Pathummal Beevi and Dr.Mani Chellappan.

I wish to extend my gratitude to Dr.Sally K. Mathew, Associate Professor, Department of Plant Pathology for the laboratory facilities given to me during the course of study.

It is my duty to thank Dr.J.Poorani, PDBC, Bangalore and Dr.Ramamoorthy, Indian Agricultural Research Institute, New Delhi for their esteemed service in identifying the coccinellid species.

I sincerely acknowledge the help extended by the staff BCCP, Vellanikkara in rice field surveys.

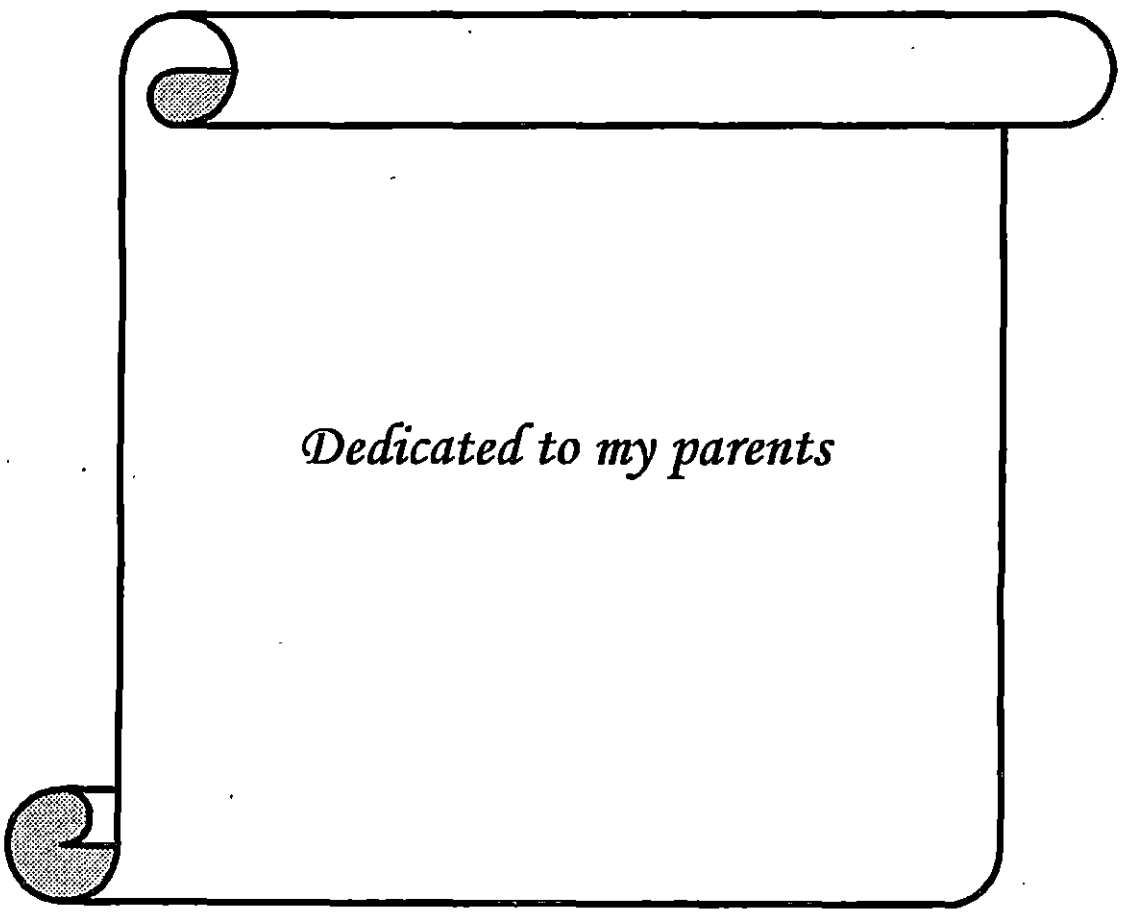
It is my duty to express my thanks to Byju, Sindhu, Dona, Rajan, Smilu, Hena, Sujayya, Sumiya, Arjitha, Smitha Ravi, Basanth, Renitha, Deepthi, Deepa, Vidhu, Subha, Divya, Amritha, Vidya, Parvathi and Felitte for their kind co-operation rendered to me during the thesis work.

I am thankful to the Kerala Agricultural University for awarding the KAU fellowship.

Above all, I submit my sincere and respectful regards to Papa, Mummy and brother for all their blessings and support without which this work would not have taken good shape.

08/12/03

QUENO JOSE


Dedicated to my parents

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INTRODUCTION

1. INTRODUCTION

Among the various families of Coleoptera, the family Coccinellidae has outstanding importance since most of the species are predaceous on other insect pests and hence widely used in biological pest suppression. Members of this family are commonly called as lady bird beetles. They are brightly coloured in various shades of red, black and brown and usually spotted. Both the adults and grubs are voracious feeders on various sucking pests like aphids, mealybugs, scales, white flies, psyllids, phytophagous mites etc., which are injurious to agricultural and forest crops.

The value of lady bird beetles as natural predators has been recognized since mid 19th century. The first well planned and successful biological control attempt was undertaken during 1887-88, when citrus industry in California was seriously threatened by cottony cushion scale, *Icerya purchasi* Maskell (Doutt, 1964). The Australian lady bird beetle, *Rodolia cardinalis* Mulsant was introduced to California and within a year spectacular control was achieved. In 1929, this notorious scale insect got introduced into India in the Nilgiri Hills, where *R. cardinalis* imported from California gave a substantial success.

In India, the earliest attempt of introduction of a natural enemy was in 1898 when a coccinellid, *Cryptolaemus montrouzieri* Mulsant from Australia was released against coffee green scale, *Coccus viridis* (Green).

Success in biological control is often dependant on a thorough understanding of the organisms involved both injurious and beneficial and their intricate interactions with each other and with abiotic environment. Basic studies on systematics, biology and ecology of pests and their natural enemies are therefore an integral part of biological control. Taxonomy plays a key role in biological control in identifying the pest species and their natural enemies. Biological control and taxonomy are thus interdependant branches of science. The first step in any investigation on the role of natural enemies in pest control involves a field survey to determine the species present and how their numbers vary in relation to those of insect pests. The species composition and diversity of predatory coccinellids in an agro-ecosystem is mainly determined by the species diversity

and kind of prey in the habitat and also the environmental factors prevailing there. No systematic study of coccinellids has been made in Kerala till date and an up to date key for the identification of the commonly available species of lady bird beetles is lacking.

The present study entitled "Taxonomy of predatory coccinellid beetles (Coccinellidae : Coleoptera) in rice and vegetable crops" was taken up with the following objectives:

1. To study the species composition and diversity of coccinellid predators in rice and vegetable fields of Vellanikkara.
2. To study the taxonomy of predatory coccinellid beetles prevalent in rice and vegetable fields of Vellanikkara.
3. To prepare a key for the identification of the predatory coccinellids collected during the study.

Review of Literature

2. REVIEW OF LITERATURE

2.1 Taxonomy

Coccinellidae are placed in the super family Cucujoidea in the suborder Polyphaga. The super family Cucujoidea includes many small families and their relationships are extremely complicated. Jennel and Paulian (1944) divided Cucujoidea into nine sections and described a new section Coccinellaria to include Coccinellidae and Endomychidae.

2.1.1 Subfamilies and tribes of Coccinellidae

Sasaji (1968) established a new system of classification of the family Coccinellidae from the view point of phylogeny, based on comparative morphology of both larvae and adults. He recognised six subfamilies and 19 tribes. These are as follows:

Subfamily	Tribes
Sticholotinae	Sukunahikonini, Serangiini, Sticholotini, Shirozuellini
Scymninae	Stethorini, Scymnini, Ortalini, Aspidimerini, Hyperaspini
Chilocorinae	Telsimiini, Platynaspini, Chilocorini
Coccidulinae	Lithophilini, Coccidulini, Exoplectrini, Noviini
Coccinellinae	Coccinellini, Psylloborini
Epilachninae	Epilachnini

Ahmed (1973) described a new tribe Ghanini, under the subfamily Chilocorini for inclusion of the genus *Ghanius*. The species of this tribe fed on scale insects in Pakistan. Gordon *et al*. (1989) erected a new tribe Carinodulini for the inclusion of *Carinodula campbelli* from Mexico.

2.1.2 Genera and species of predaceous Coccinellidae with special reference to Asia

Four hundred species of predaceous coccinellids have been reported from India so far. The pioneer worker was Subramaniam (1923) who gave a list of 20 coccinellids of South India along with their prey and their distribution. Ayyar (1925) described a new species *Scymnus coccivora* Ayyar, predator of the neem scale, *Chloropulvinaria maxima* (Green) from India.

Kapur (1948a) studied the old world species of the genus *Stethorus* Weise and described 12 new species. Later he (Kapur, 1948b) revised Indian species of *Rodolia* Mulsant and added three new species *viz*., *R. amabilis, R. ruficollis* and *R. breviscula*. Puttarudriah and Channabasavanna (1953, 1955 and 1956) recorded 53 species in 23 genera grouped in eight tribes and five sub-families from the erst-while Mysore state.Usman and Puttarudriah (1955) listed 48 species of predaceous Coccinellidae from the erst-while Mysore state.

Kapur (1954) studied the systematics and biology of coccinellid predators on the San Jose scale, *Quadraspidiotus perniciosus* (Comstock) in Kashmir. Kapur (1961) described a new species *Stethorus keralicus* preying on the areca palm mites. A new species *Adalia simmondsi* feeding on *Adelges* sp. was described by Kapur and Rao (1962) from North Western India.

Chapin (1962) erected a new genus, namely, *Pseudoscymnus* in the tribe Scymnini. Monograph of coccinellid fauna of Micronesia was given by Chapin (1965b) which includes 48 species under 24 genera.

Chelliah (1965) described the male genitalia of four species of coccinellids viz., *Pullus coccidivora* Aiyar, *Pullus quadrillum* Motschulsky, *Pharoscymnus horni* Weise and *Nephus regularis* Sicard. Azim and Ahmed

(1966) observed seven colour variants of *Cheilomenes sexmaculata* Fabricius from Pakistan. A new species *Pseudoscymnus simmondsi* feeding on scale insects was described by Chapin and Ahmed (1966). A checklist of Coccinellidae of Andaman Islands was also prepared by Kapur (1967).

Ahmed (1968) described *Pseudoscymnus murreensis* as a new species from Pakistan. Nagaraja and Hussainy (1968) gave descriptions, notes on distribution and diagnostic key for six species of *Chilocorus* viz., *C. bijugus* Mulsant, *C. circumdatus* Schonherr, *C. hauseri* Weise, *C. kuwanae* Silvestri, *C. nigritus* (Fabricius) and *C. rubidus* Hope predaceous on San Jose scale, *Q. perniciosus* and other coccids in India.

Kapur and Munshi (1970) described a new species, *Scymnus* (*Pullus*) *nymphaeus* predaceous on the aphid, *Rhopalosiphum nymphaeae* (Linnaeus) in Calcutta. *P. simmondsi* Ahmed preying on scale insects in Pakistan was described by Ahmed (1970). Sasaji (1971) provided keys for the subfamilies, tribes, genera and species of the old world Coccinellidae. 17 species of Coccinellidae were recorded by Kapur (1972) from Goa.

Ghorpade (1974) described a new species, *Cryptogonus kapuri* of the tribe Aspidimerini from Bangalore. He provided a key to the known species of *Cryptogonus bilineatus* group. A new species, *viz.*, *Pseudoscymnus dwipakalpa* preying on *Aspidiotus destructor* Signoret was also described by Ghorpade (1977) from Bangalore. Great head and Pope (1977) clarified some of the nomenclatural problems of the species of *Chilocorus* feeding on diaspidid scales.

Gordon (1978) described several West Indian Coccinellidae, mostly scale predators, representing five tribes. One new genus and four new species were described and keys to the genera and species were provided.

Thirty species of Coccinellidae belonging to 18 genera and 2 subfamilies were recorded from Chandigarh by Pajni and Singh (1982). Gordon and Chapin (1983) revised the mite feeding coccinellid genus *Stethorus* in the western hemisphere recognising 21 species of which 11 were new.

Pajni and Verma (1985) described and illustrated the male genitalia of 25 coccinellid species belonging to 15 genera collected from Chandigarh. Fourty six species of Coccinellidae of Nepal belonging to 27 genera were enumerated by Miyatake (1985). Of these, nine species were described as new. Yoon and Park (1985) provided a taxonomic revision of the subfamily Coccinellinae of Korea.

The type materials of 36 species of Coccinellidae from northern India and Nepal in the Geneva Museum were studied by Canepari (1986). Booth and Pope (1986) in their review of the genus *Cryptolaemus*, recognized two species groups. The *montrouzieri* group, comprising *Cryptolaemus montrouzieri* Mulsant, *C. affinis* Crotch, *C. wallacei* Crotch, *C. simplex* Blackburn, *C. sinestria* Booth and Pope and *C. crotchi* Booth and Pope and the *subvilaceus* group, comprising *C. subvilaceus* Crotch and *C. concinus* Weise.

Debaraj and Singh (1990) studied the taxonomic characters of *Coccinella transversalis* Fabricius. *Aponephus lentiformis* Booth, a new genus and species of the tribe Scymnini associated with *Rastrococcus iceryoides* was described from southern India (Booth, 1991).

Bhaskar (1992) re-described thirty one species belonging to five tribes representing five subfamilies namely Sticholotinae, Scymninae, Chilocorinae, Coccidulinae and Coccinellinae from Karnataka.

Omkar and Pervez (2000) studied the morphology of *Micraspis discolor* and revealed that there exists well marked sexual dimorphism in the species. Poorani (2002) prepared an annotated checklist of the Coccinellidae of the Indian subregion comprising 400 species belonging to five subfamilies, namely, Scymninae, Coccinellinae, Sticholotidinae, Chilocorinae and Coccidulinae.

2.2 Species diversity of predatory coccinellids

Coccinellid predators reported from rice, vegetable fields and orchard systems along with their associated prey are represented in Table 1.

2.2.1 Rice

In Kerala large numbers of the coccinellid, *Coccinella arcuata* Fabricius were found feeding on *Nilaparvata lugens* Stal during heavy infestation (Abraham *et al.*, 1973). Mammen and Nair (1977) observed the adults of *Harmonia arcuata* Mulsant feeding on the nymphs and adults of *Baliothrips biformis* (Bagnall) on rice in Kerala. Mancharan and Jayaraj (1979) reported *C. arcuata* as a promising biocontrol agent of *N. lugens*. *Coccinella repanda* Thunberg and *M. sexmaculatus* were predaceous on *N. lugens* in Mandya (Manjunath, 1979). Samal and Misra (1982) observed the larvae of *C. repanda* feeding on nymphs of *N. lugens* on rice at Cuttack. Adults of *B. suturalis* were found preying on nymphs and adults of *Sogatella furcifera* (Hovarth) and nymphs of *Nephotettix virescens* (Distant) in New Delhi (Garg and Sethi, 1983).

Three species of Coccinellids, *Coccinella billieti* (Mulsant), *Oenopia* sp. and *C. repanda* were observed feeding on *N. lugens* in rice (Natarajan and Mathur, 1981; Samal and Misra, 1984). Samal and Misra (1985) observed the larvae of *M. discolor* preying on nymphs and adults of *N. lugens* on rice in Cuttack. *B. suturalis, C. septempunctata, M. sexmaculatus* and *Scymnus* sp. were found associated with rice leaf and plant hoppers (Kaushik *et al.*, 1986). Thakur *et al.* (1991) observed *M. sexmaculata, Coccinella* sp. and *Brumus* spp. preying on *N. lugens* in rice in North Eastern Madhya Pradesh.

Studies in RRS, Moncompu and farmers' fields of Kuttanadu during Kharif and Rabi seasons of 1996 and 1997 revealed the presence of large number of natural enemies of rice pests (Ambikadevi, 1998). Among the natural enemies coccinellid predators, *Micraspis* sp. and *M. sexmaculatus* showed higher rates of

predation. *Micraspis* sp. has been reported as the most important coccinellid predator in different rice ecosystems of Kerala (Ambikadevi *et al.*, 1998; Bhaskar, 1999; Beevi *et al.*, 2000).

Table 1. Coccinellid predators and their associated prey in different agro ecosystems

Crop	Predator	Prey	References
Rice	*Coccinella transversalis* (Fabricius)	*Nilaparvata lugens* Stal	Manjunath, 1979
	Brumoides suturalis (Fabricius)	*Sogatella furcifera* (Horvath) & *Nephotettix virescens* (Distant)	Garg and Sethi, 1983 Kaushik *et al.*, 1986 Thakur *et al.*, 1991
	Cheilomenes sexmaculata (Fabricius)	*N. lugens*	Manjunath, 1979
		N. lugens	Kaushik *et al.*, 1986
		Cnaphalocrocis medinalis Linnaeus	Sarala, 1999
	Harmonia octomaculata (Fabricius)	*Baliothrips biformis* (Bagnall)	Mammen and Nair, 1977
		N. lugens	
	Micraspis discolor (Fabricius)	*N. lugens*	Abraham *et al.*, 1973 Samal and Misra, 1985
Cow pea	*Cheilomenes sexmaculata*	*Aphis craccivora* Koch.	Sheena, 2003
	Coccinella transversalis	*A. craccivora*	Singh and Singh, 1985 Debaraj and Singh, 1990
	Brumoides suturalis	*A. craccivora*	Sheena, 2003
	Jauravia soror(Weise)	*A. craccivora*	Sheena, 2003
	Micraspis crocea (Fabricius)	*A. craccivora*	Sheena, 2003
	Harmonia arcuata	*A. craccivora*	Bindu, 1997 Agarwala and Ghosh, 1988
Mustard	*C. sexmaculata*	*Lipaphis erysimi* Kaltenback	Ray, 1967
Cabbage	*Coccinella transversalis*	*Brevicoryne brassicae* (Linnaeus)	Bhaskar and Viraktamath,2002b
	Menochilus sexmaculata F.	,,	,,
	Harmonia octomaculata	*Myzus persicae* Sulzer	,,
Sugarcane	*Cheilomenes sexmaculata*	*Melanaspis indosacchari*	Easwaramoorthy *et al.*, 1998
	Pharoscymnus horni Mulsant	*Melanaspis glomerata* (Green)	Singh, 2001
Bhendi	*Cheilomenes sexmaculata*	*A. gossypii*	Sumathy, 1999

Contd.

Table 1. continued.

Crop	Predator	Prey	References
Coffee	*Cryptolaemus montrouzieri* Mulsant	*Planococcus* sp.	Singh, 2001
Banana	*M. sexmaculata*	*Pentalonia nigronervosa* Coq.	Padmalatha & Singh, 1998
	Coccinella septempunctata Linnaeus	,,	,,
	Scymnus quadrillum (Motschulsky)	,,	,,
	Scymnus pyrocheilus (Motschulsky)	,,	,,
	Pseudaspidimerus circumflexa (Motschulsky)	,,	,,
	C. transversalis	,,	George, 1999
Mango	*Cryptolaemus montrouzieri*	*Ferrisia virgata* (Cockerell) *Dysmiococcus* sp.	Bhaskar&Viraktamath, 2002a
Guava	*C. montrouzieri*	*Chloropulvinaria* psidii (Maskell) *F. virgata*	Singh, 2001 Bhaskar and Viraktamath, 2001b
Grape	*Scymnus coccivora* Ayyar	*Maconellicocus hirsutus* Green	Mani, 1986
Coconut	*Chilocorus nigrita* (Fabricius)	*Aspidiotus destructor* Signoret	Pandian *et al.* 2002
Citrus	*Rodolia cardinalis* (Mulsant)	*Icerya purchasi* Maskell	Singh, 2001
	C. montrouzieri	*Planococcus citri* (Risso)	,,

2.2.2 Vegetables

The coccinellid, *C. sexmaculata* was recorded as a predator of the aphid, *Aphis craccivora* Koch. (Bagas and Trehan, 1949). Puttarudriah and Channabasavanna (1953, 1955 and 1956) reported 53 predatory coccinellids from Karnataka preying on coccids, aphids, mealybugs and mites. Ray (1967) reported that *C. sexmaculata* is a well known predator of aphids, infesting plants in Ranchi. According to Saharia (1980), *C. sexmaculata* was the most abundant predator of *A. craccivora* because of its short life cycle, larger populations and fairly high feeding potential.

During the course of studies on Indian Coccinellidae, a few larvae of *C. montrouzieri* were seen feeding on a colony of *Aphis gossypii* Glover on *H. rosasinensis* near Bangalore (Ghorpade, 1981).

Coccinella transversalis F. was reported to feed on 15 different aphid species (Agarwala and Saha, 1986). Agarwala and Gosh (1988) reported the occurrence of 30 species of aphidophagous coccinellids in India and this includes *B. suturalis, C. nigritus, C. septempunctata, C. transversalis, Harmonia octomaculata* (Fabricius), *M. sexmaculatus, Pseudaspidimerus circumflexus* (Motschulsky), *Scymnus pyrocheilus* (Motschulsky) and *Scymnus quadrillum* (Motschulsky) among others.

Parasuraman (1989) found eight species of coccinellids feeding on *A. craccivora* in cowpea of which *M. sexmaculatus* and *Scymnus* sp. were dominant constituting 43 per cent and 25 per cent of the total predatory population respectively.

Seven species of coccinellids namely, *C. septempunctata, C. divasicata, Coccinella* sp., *Micraspis discolor, Menochilus* sp., *M. sexmaculatus* and *C. transversalis* were observed to be feeding on *A. craccivora* on *Lathyrus*, Lentil and chickpea and among them *C. septempunctata* was the most abundant (Sharma, 1991). Four coccinellid predators viz., *C. transversalis* , *M. sexmaculatus* , *C. septempunctata* and *M. discolor* were found to be feeding on aphids in Brinjal

(Veeravel, 1995). Shantibala and Singh (1995) surveyed aphidophagous coccinellids in Manipur and Nagaland and revealed the existence of 46 species under 6 tribes. Ofuya (1995) observed that the population of *A. craccivora* can be considerably reduced by the action of the coccinellid predator *Cheilomenes lunata* (Fabricius).

Rani (1995) reported four coccinellid predators namely, *C. sexmaculata, C. septempunctata, Scymnus* sp. and *Micraspis crocea* (Fabricius) preying on pea aphid, *A. craccivora* from Thiruvananthapuram. In Kerala, coccinellid predators, viz., *M. sexmaculatus, M. crocea* and *Scymnus* sp. were found to be associated with cowpea aphid, *A. craccivora* even in insecticide sprayed plots (Bindu, 1997). Chandrababu *et al.* (1997) reported *B. suturalis* feeding on three species of mealybugs, *viz., F. virgata, Planococcus pacificus* Cox. and *Maconellicoccus hirsutus* (Green) and one species of aphid *A. craccivora.*

Survey on coccinellid predators in mustard ecosystem revealed that four species of coccinellids, *viz., C. septempunctata, C. transversalis, M. sexmaculatus* and *B. suturalis* were present in mustard field and *C. septempunctata* and *C. transversalis* were important aphidophagous coccinellid predators of mustard aphid (Singh and Rai, 2000).

Bhaskar and Viraktamath (2001a) reported the occurrence of *B. suturalis , M. sexmaculatus* and *Rodolia fumida* Mulsant associated with the prey *Coccidohystrix insolitus* (Green), *A. craccivora* and *Icerya purchasi* Maskell respectively in red gram ecosystem. Three species of coccinellids, viz., *C. transversalis, M. sexmaculatus* and *H. octomaculata* were found predating on aphids, *Myzus persicae* (Sulzer) and *Brevicoryne brassicae* (Linnaeus) in cabbage field (Bhaskar and Viraktamath, 2002b). Four species of coccinellids namely, *C. transversalis, C. sexmaculata, B. suturalis* and *J. soror* were found to be the major predators of the aphid, *A. craccivora* in vegetable fields of Thrissur (Sheena, 2003).

2.2.3 Orchards

Puttarudriah *et al.* (1952) observed that *C. montrouzieri* was associated with infestations of the mealybugs, *Chloropulvinaria* and *Pseudococcus* on mango and guava in Karnataka. *M. sexmaculatus* was reported preying on the citrus aphid, *Toxoptera aurantii* (Boy) on tea in India (Das and Rava, 1968). In coconut the scale, *Aspidiotus destructor* Signoret was observed to be preyed upon by the coccinellid, *P. dwipakalpa* from Karnataka (Ghorpade, 1977). Adults and larvae of *M. sexmaculatus* were feeding on the eggs and nymphs of *Oligonychus mangifera* (Rahman and Sapra) from Karnataka (Ghorpade and Channa Basavanna, 1979).

Mani (1986) reported *S. coccivora, Scymnus sp.* and *C. montrouzieri* as natural enemies of the *Hibiscus* mealybug, *Maconellicoccus hirsutus* (Green) on grape vine. Narasimham and Chacko (1988) reported a coccinellid beetle belonging to a genus near *Nephus* feeding on *Rastrococcus iceryoides* in India, which was later described by Booth (1991) as *Aponephus lentiformis*. Sharma *et al.* (1990) reported *Pharoscymnus flexibilis* Mulsant as an efficient predator of San Jose scale consuming the crawlers throughout its larval and adult life span.

In guava orchards, five species of predatory coccinellids namely, *C. montrouzieri, M. sexmaculatus, Jauravia soror* (Weise), *C. nigrita* and *S. (Scymnus) nubilis* Mulsant were found to be feeding on *C. psidii, F. virgata* and *C. viridis*, whereas in sapota orchards most abundant species were *C. montrouzieri, J. soror, C. nigrita* and *Scymnus (Pullus) xerampelinus* Mulsant preying on *C. viridis* and *Chloropulvinaria psidii* Green (Bhaskar and Viraktamath, 2001b). *C. montrouzieri* was reported as an efficient predator of mealybugs, *Dysmiococcus sp.* and *F. virgata* in mango orchards. (Bhaskar and Viraktamath, 2002a).

Materials and Methods

3. MATERIALS AND METHODS

The present study was conducted at College of Horticulture, Vellanikkara during the period from November 2001 to August 2003. The methodology followed for the study is detailed below.

3.1 SPECIES COMPOSITION AND DIVERSITY OF COCCINELLID PREDATORS

Intensive collection of predatory coccinellid beetles was made from rice and vegetable crops in and around Vellanikkara. Field collections were done from vegetables, namely, cowpea, coccinia, bittergourd, brinjal and bhendi fields of College of Horticulture, Vellanikkara and also from farmers' fields at Vellanikkara. In rice, field surveys were conducted at Agricultural Research Station and Seed Farm, Mannuthy and farmers' fields at Nettissery. The different species of coccinellid beetles and their associated prey encountered during the study were documented.

3.2 TAXONOMY

Taxonomic studies were conducted in the laboratories of the Departments of Agricultural Entomology and Plant Pathology, College of Horticulture, Vellanikkara.

3.2.1 Collection and preparation of specimens for study

Coccinellid beetles were collected by hand picking and using sweepnet. The collected beetles were killed using ethyl acetate soaked cotton in killing bottles, and mounted on rectangular cards, using gluestick. Each specimen was labelled with the information about locality, date of collection, collector's name and the associated prey and host plant.

3.2.2 Identification

Identification of specimens were done with the use of literature listed under references and with the help of taxonomists at Project Directorate of Biological Control, Bangalore and Indian Agricultural Research Institute, New Delhi.

3.2.3 Preparation of genitalia and mouth parts

The abdomen of the insect was detached from the whole specimen with the help of a fine needle and transferred to a vial containing few millilitres of 10 per cent potassium hydroxide. The vial was incubated at 50-55°C for two to six hours depending on the chitinisation of the specimen. The abdomen was transferred to a Petri dish containing water and digested tissues were pressed out with the help of fine needles. After repeated washing in water the abdomen was transferred to a drop of glycerine on a glass slide where genitalia were separated and examined under microscope.

The mouth parts were also similarly prepared for the study after dissecting them carefully using fine needles.

3.2.4 Illustrations

Different species collected were studied for the taxonomic characters and illustrations of the following appendages were made with the help of a *Camera lucida* attached to a stereo microscope..

A. Dorsal view of the beetle

B. Lateral view of the beetle

C. Antenna

D. Labrum

E. Labium

F. Mandible

G. Maxilla

H. Pronotum

I. Hind leg

J. First abdominal sternite showing coxal line and femoral line

K. Epipleura

L. Sipho of male

M_1. Dorsal view of tegmen of male

M_2. Ventral view of tegmen of male

N. Ninth abdominal segment of male

O. Hemisternite of female

P. Spermatheca of female

The photographs were made using 35 mm SLR camera with photomicrographic attachment.

4. RESULTS

4.1 SPECIES COMPOSITION AND DIVERSITY OF COCCINELLID PREDATORS

A total of sixteen species of coccinellids were collected from rice, cowpea, bittergourd, coccinia, bhindi and brinjal. The species of coccinellids and their associated prey in rice and vegetable fields surveyed during the study is given in Table 2.

4.1.1 Rice

Five species of coccinellids were collected from the rice fields of Mannuthy, namely, *Coccinella transversalis* Fabricius, *Cheilomenes sexmaculata* Fabricius, *Brumoides suturalis* Fabricius, *Harmonia octomaculata* Fabricius and *Micraspis discolor* Fabricius. Leafhoppers, planthoppers, leaf folder and stem borer were recorded from the field. But none of the predators were observed feeding on these prey during this study.

4.1.2 Vegetables

In cowpea fields, the aphid, *Aphis craccivora* was found to be predated by *C. transversalis, C. sexmaculata, Anegleis cardoni, B. suturalis, Jauravia soror, Scymnus (Pullus) latemaculatus, Pseudaspidimerus trinotatus, H. octomaculata, Scymnus (Scymnus) nubilus* and *Cryptogonus orbiculus* .

Associated with the aphid, *Aphis gossypii* Glover in bittergourd, the coccinellids, *viz.* , *Coccinella transversalis, Cheilomenes sexmaculata, Scymnus (Pullus) pyrocheilus* and *P. trinotatus* were observed .

In coccinia four coccinellid predators recorded were, *P. trinotatus, Jauravia pallidula, Jauravia dorsalis* and *S. (P.) pyrocheilus*. Of the four species, *S. (P.) pyrocheilus*, was feeding on *Ferrisia virgata*, while the other species preyed upon and *A. gossypii*.

C. sexmaculata was recorded in Bhindi feeding on *A. gossypii*. In brinjal, *P. trinotatus, Pseudoscymnus* sp. and *Scymnus (Pullus) coccivora* were actively feeding on the mealybug, *Coccidohystrix insolitus* .

Table 2. Species diversity of coccinellid predators in rice and vegetable fields

Crop	Prey	Predator
Cowpea	*Coccinella transversalis* Fabricius	*Aphis craccivora* Koch
	Cheilomenes sexmaculata Fabricius	,,
	Anegleis cardoni (Weise)	,,
	Brumoides suturalis Fabricius	,,
	Jauravia soror Weise	,,
	Scymnus (Pullus) latemaculatus Motschulsky	,,
	Pseudaspidimerus trinotatus Motschulsky	,,
	Harmonia octomaculata Fabricius	,,
	Cryptogonus orbiculus (Gyllenhal)	,,
	Scymnus (Scymnus) nubilus Mulsant	
Bittergourd	*Coccinella transversalis*	*Aphis gossypii* Glover
	Cheilomenes sexmaculata	,,
	Scymnus (Pullus) pyrocheilus Mulsant	,,
	P. trinotatus	,,
Coccinea	*P. trinotatus*	*Aphis gossypii*
	S. (P.) pyrocheilus	*Ferrisia virgata* Cockerell
	Jauravia pallidula Motschulsky	*Aphis gossypii*
	Jauravia dorsalis Weise	,,
Bhindi	*C. sexmaculatus*	*A. gossypii*
Brinjal	*P. trinotatus*	*Coccidohystrix insolitus* Green
	Scymnus (Pullus) coccivora Ayyar	,,
	Pseudoscymnus sp.	
Rice	*Micraspis discolor* Fabricius	
	B. suturalis	
	Coccinella transversalis	
	Cheilomenes sexmaculata	
	H. octomaculata Fabricius	

4.2 TAXONOMY

Of the sixteen species collected during the study, only eleven species were utilised for detailed taxonomic studies. The eleven species studied are included in eight genera and belonging to five tribes representing four subfamilies namely, Sticholotinae (one species), Scymninae (four species), Chilocorinae (one species) and Coccinellinae (five species) (Table 3).

A synoptic description of the taxa along with keys for identification are given. Each species is adequately illustrated.

Key to the subfamilies and tribes of Coccinellidae found during the study.

1. Terminal segment of maxillary palpi elongate, conical (Fig1a:G); mentum very narrowly articulated with submentum ..... **Subfamily: Sticholotidinae, Tribe: Sticholotidini**

   Terminal segment of maxillary palpi strongly divergent (Fig2a:G) apically, or nearly parallel sided (Fig7:G, 9:G), rarely slightly convergent apically; mentum usually not very narrowly articulated with submentum..... 2

2. Antennae relatively long at least 0.5 as long as wide, usually longer than 0.66; terminal segment of maxillay palpi strongly divergent apically (Fig2a:G, 3a:G); coxites of female genitalia oval (Fig4b:O) or transverse (Fig2b:O); dorsum glabrous..... **Subfamily: Coccinellinae, Tribe: Coccinellini**

   Antennae relatively short, atmost 0.66 as long as head width, often very short; terminal segment of maxillary palpi nearly parallel sided (Fig.7:G, 9:G)), never strongly divergent..... 3

3. Clypeus strongly expanded laterally; anterior margin of pronotum deeply, trapezoidally concave, lateral portions strongly descending below; elytral base distinctly broader than pronotal base; elytral epipleura broad or its inner carinae reaching elytral apex (Fig7:K)..... **Subfamily: Chilocorinae, Tribe: Chilocorini**

Table 3. Coccinellid predators used in taxonomic studies

Sub family	Tribes	Species
Sticholotidinae	Sticholotidini	*Jauravia soror* Weise
Scymninae	Scymnini	*Scymnus (Pullus) pyrocheilus* Mulsant *Scymnus (Pullus) latemaculatus* Motschulsky *Scymnus (Pullus) coccivora* Ayyar
	Aspidimerini	*Pseudaspidimerus trinotatus* Thunberg
Chilocorinae	Chilocorini	*Brumoides suturalis* Fabricius
Coccinellinae	Coccinellini	*Cheilomenes sexmaculata* (Fabricius) *Harmonia octomaculata* (Fabricius) *Coccinella transversalis* Fabricius *Micraspis discolor* (Fabricius) *Anegleis cardoni* (Weise)

Clypeus not strongly expanded laterally; pronotum not as above; elytral base slightly broader than pronotal base; elytral epipleura narrow, inner carina not reaching elytral apex (Fig8a:K)..... **Subfamily: Scymninae** **4**

4. Eyes entire, do not extend to the under surface of the head; antennae geniculate, nine segmented, first two segments disproportionately enlarged; first visible abdominal sternite dilated posteriorly in an arc in the middle..... ..... **Tribe: Aspidimerini**

Eyes extend to undersurface of head; antennae not geniculate, ten segmented; first abdominal sternite not as above..... **Tribe: Scymnini**

Sub Family: Sticholotidinae

Body small to minute; head capsule sometimes projected anteriorly;. antennae moderately long and usually inserted more or less dorsally, rarely laterally; clypeus distinctly expanded laterally; terminal segment of maxillary palpi conical or elongate oval, usually distinctly narrowing apically but rarely slightly broadened apically; mentum narrowly articulated with submentum; abdomen with either five or six visible segmented; apophysis of ninth abdominal sternite flat and triangular with sclerotized external margins; sipho of male genitalia usually weakly curved; tegmen provided with a dorso-basal projection at basal piece; hemi-sternites of female very elongate; tarsi usually cryptotetramerous or nearly trimerous.

Tribe: Sticholotidini

Body oval to round, usually small, dorsum usually strongly convex, pubescent or glabrous; antennae consisting of seven to eleven segments, club more or less distinct; maxillary palpus elongate, terminal segment usually conical; elytra without distinct carinae along external margins; abdomen with five visible segments, the fifth usually distinctly longer than preceding.

Only one species, namely, *Jauravia soror* belonging to this tribe Sticholotidini was collected during the study.

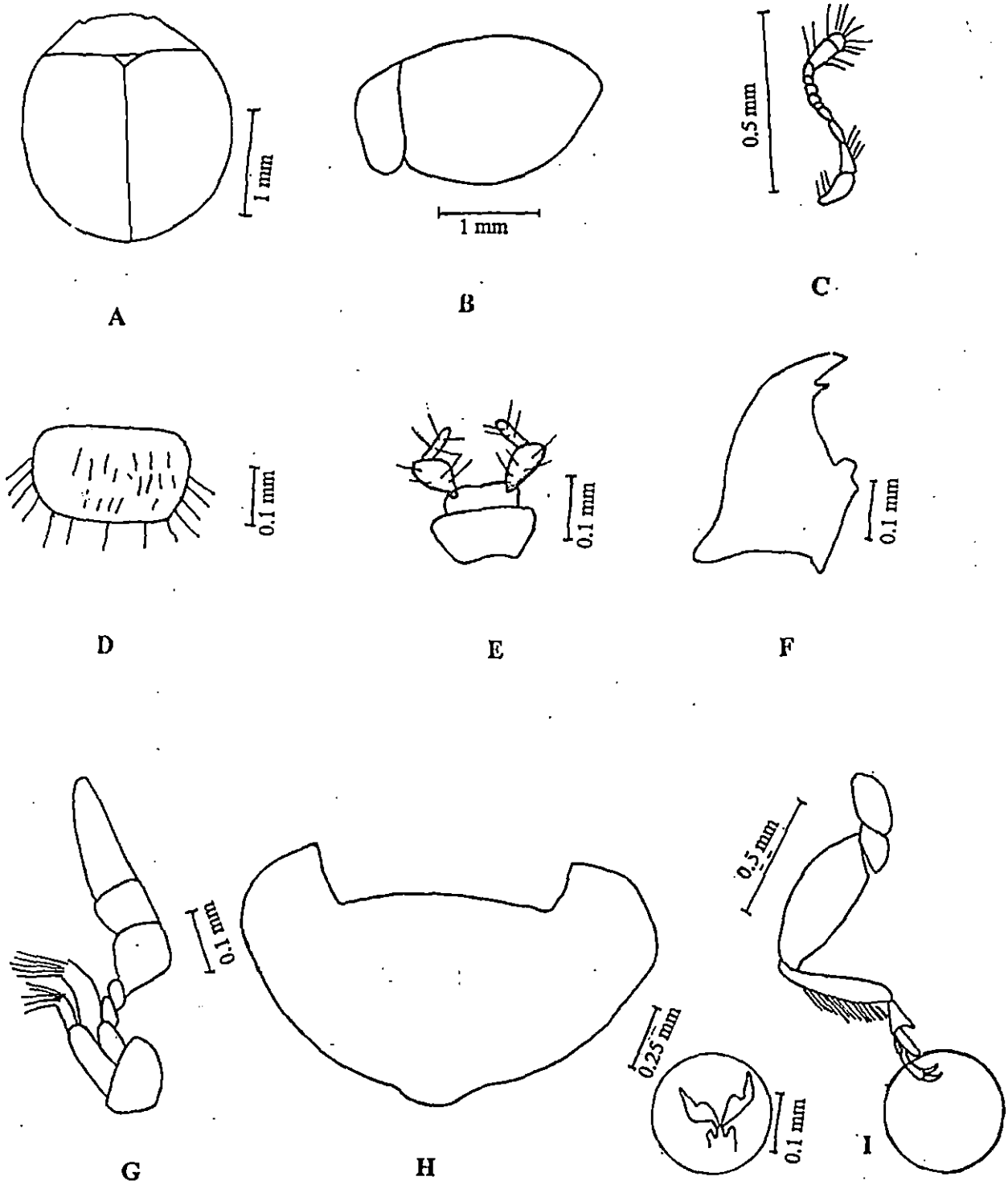
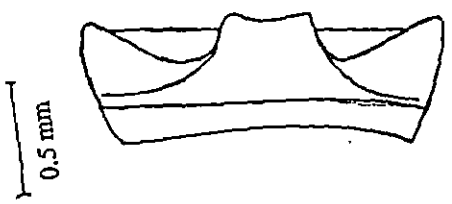
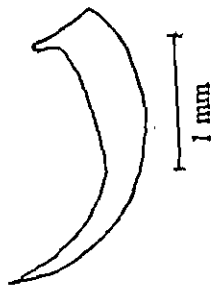


Fig. 1a. ***Jauravia soror***

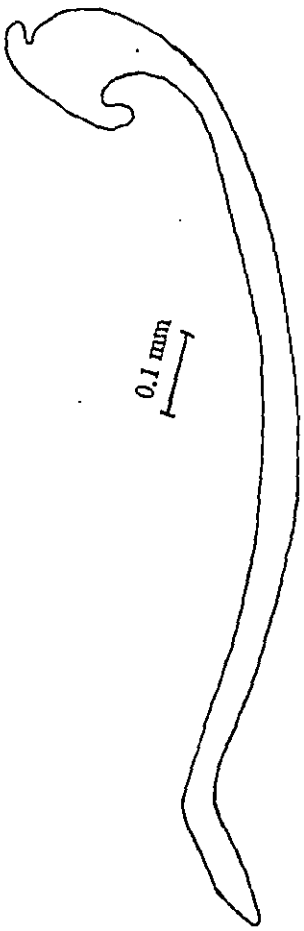
A. Dorsal view of the beetle; B. Lateral view of the beetle; C. Antenna; D. Labrum
E. Labium; F. Mandible; G. Maxilla; H. Pronotum; I. Hind leg



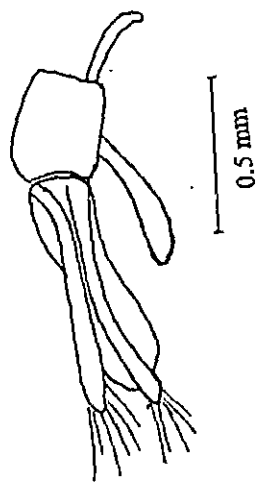
J



K



L



M_1

Fig. 1b. ***Jauravia soror***

J. First abdominal sternite showing coxal line and femoral line; K. Epipleura; L. Sipho of male; M_1. Dorsal view of tegmen of male

***Jauravia soror* (Weise)(Plate 1; Fig. 1a & 1b)**

Clanis soror Weise, 1892:25

Jauravia soror : Korschefsky, 1931:222

Jauravia pubescens Gorham (*nec* Fabricius),1894: 204 - Korschefsky, 1931: 222 (Syn.)

Body uniformly brownish orange with black compound eyes and mandible tips.

Body round, pubescent, small; head 0.35 times as wide as the body, coarsely, sparsely punctuate with one white hair arising from each puncta; inner ocular margin curved; mouth parts as in Fig.1a; antenna 11 segmented, last two segments broader than the rest; prothorax 0.65 times as wide as the body, coarsely, densely punctate, pubescent, slightly projected anteriorly; elytra closely, densely punctate; epipleura moderately developed; coxal line slightly curved and complete; femoral line incomplete.

Male genitalia: Sipho nearly straight except at the tip where it is slightly curved outwards, tip pointed; inner process of siphonal capsule is curved; tegmen long, lateral lobes longer than median lobe, lateral lobes narrow and pointed, median lobe flattened.

Measurements (mm): Body length - 1.82 (1.68 - 1.98), width - 1.70 (1.62 - 1.83)

Materials examined: 5 males, Vellanikkara,Thrissur, 2002, on *A. craccivora*

Sub Family: Coccinellinae

Antenna usually eleven segmented and weakly clubbed with normal length; mandibles with a basal tooth; terminal segment of maxillary palpi distinctly broadening apically and securiform; abdomen with six visible segments in both sexes; legs rather long and not strongly modified; tarsi cryptotetramerous; elytral epipleura usually broad, without deep foveae for the reception of the femoral tips; genital plates of female neither very long triangle nor strongly transverse; lateral lobes of tegmen of male genitalia neither very much longer nor shorter than median piece.

Tribe: Coccinellini

Body large to medium sized, usually short, oval or hemispherical, rarely elongate oval; dorsum always glabrous; antenna rather long at least nearly as long as inter ocular distance, eleven segmented and weakly but distinctly clavate; apical segment of maxillary palp usually strongly divergent apically and distally securiform; mandible with bifid tip and a basal tooth.

Five species belonging to five genera of the tribe Coccinellini were collected during the study and they can be identified using the key given below.

Key to the species under the tribe Coccinellini

1. First abdominal sternum with an oblique line at latero basal part (Fig.2b: J, 3b:J); median lobe of tegmen as long as lateral lobes 2

   First abdominal sternum has no oblique line as above (Fig.5b: J, 6b: J); median lobe of tegmen shorter than the lateral lobes 4

2. Pronotum with a half moon shaped marking connected with posterior marginal stripe black; each elytron with three transverse irregular spots; inner process of siphonal capsule quadrate (Fig2b:L) and other process pointed . . . .

   Cheilomenes sexmaculata

   Pronotum without half moon shaped marking; elytral pattern vary widely; siphonal capsule not as described above 3

3. Spermatheca broadly V- shaped, of nearly uniform width (Fig:3b:P); inner process of siphonal capsule hooked; elytra reddish brown with variable number of black spots ..... ***Harmonia octomaculata***

   Spermatheca strongly curved and basally broad (Fig.4b:P); inner process of siphonal capsule elongate; elytra yellow, orange or brown with variable black

markings (Fig.4a:A), each elytron with large trilobed humeral spot . .. . ***Coccinella transversalis***

4. Elytra with two J - shaped black stripes (Fig.6a:A); pronotum orange or yellow with two median discal spots and posterior marginal transverse band . ..... ***Anegleis cardoni***

Elytra without black stripes (Fig.5a:A); pronotum with a pair of discal spots and with narrow basal black markings; the discal spot round, sometimes entirely disappears .. .. ***Micraspis discolor***

***Cheilomenes sexmaculata* (Fabricius) (Plate 2a, b, c, d; Fig. 2a & 2b)**

Coccinella sexmaculata Fabricius, 1781: 96
Cheilomenes sexmaculata: Dejean, 1837: 435 - Mulsant, 1850: 444
Menochilus sexmaculatus: Timberlake, 1943: 40
Micraspis inops: Chunram & Sasaji, 1980: 488 - Iablokoff-Khnzorian, 1982.

Head pale yellow; dorsal colouration very variable; in paler specimens, pronotum yellow with a median half moon shaped marking connected with posterior marginal stripe, black, sometimes these areas are extensively black; each elytron with three transverse irregular spots; commissural line black; scutellum black.

Body medium sized, elongate oval, dorsum relatively strongly convex and glabrous; head 0.3 times as wide as body; slightly narrower than half of pronotum, and very finely punctate; mouth parts as in Fig.2a; antenna 11 segmented, clavate,; pronotum 0.59 times as wide as the body, very finely, densely, punctate; scutellum triangular, slightly wider than long, finely and sparsely punctate; punctation on elytra distinctly coarser and sparser than on pronotum; coxal line almost straight and reaching the anterior margin; femoral line almost reaching the posterior margin and the external margin of sternum.

Male genitalia: Sipho small, slender, distally thread like, siphonal capsule well developed, inner process quadrate and outer process pointed; median lobe of

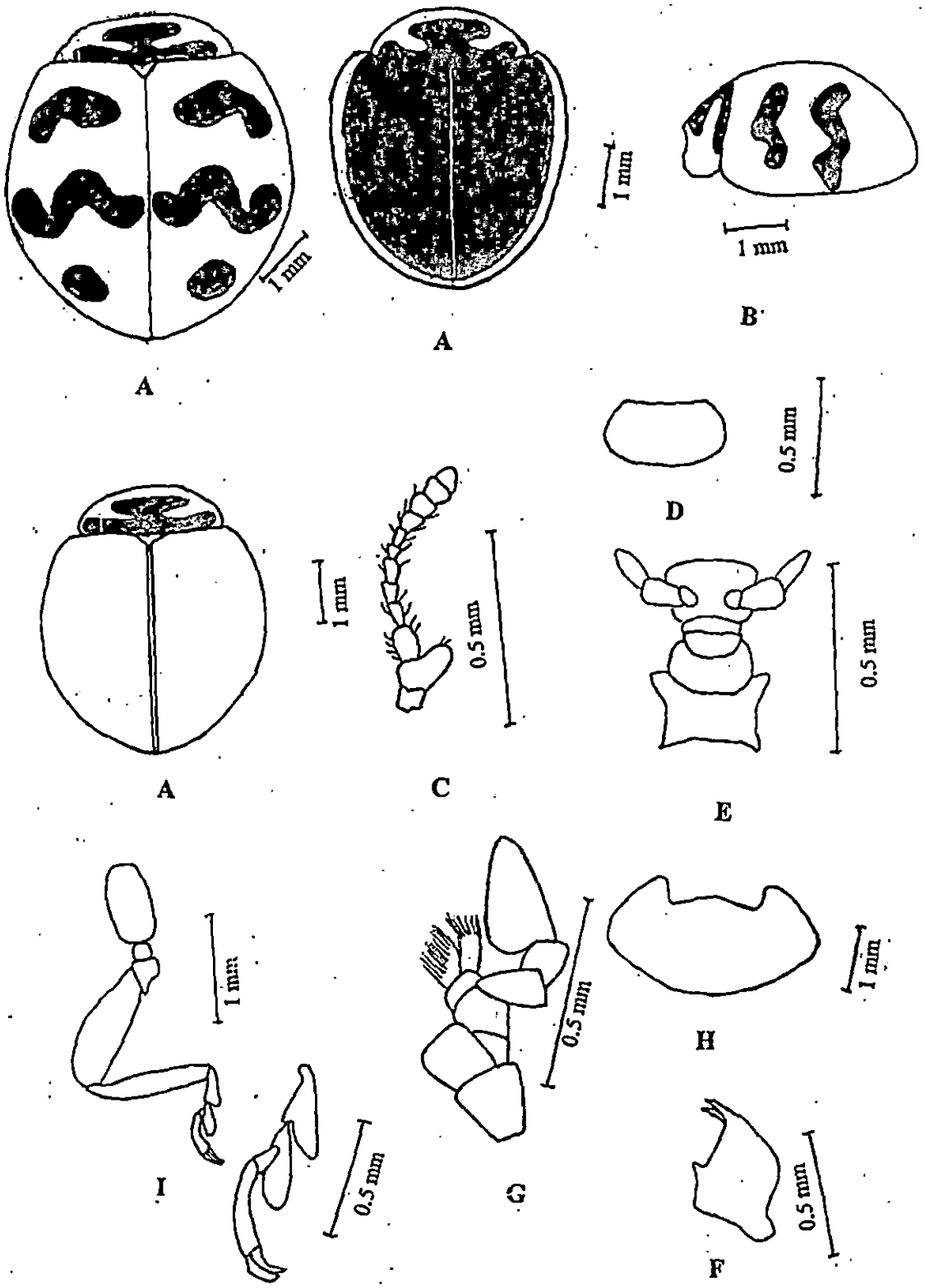


Fig. 2a. ***Cheilomenes sexmaculata***

A. Dorsal view of the beetle; B. Lateral view of the beetle; C. Antenna; D. Labrum E. Labium; F. Mandible; G. Maxilla; H. Pronotum; I. Hind leg

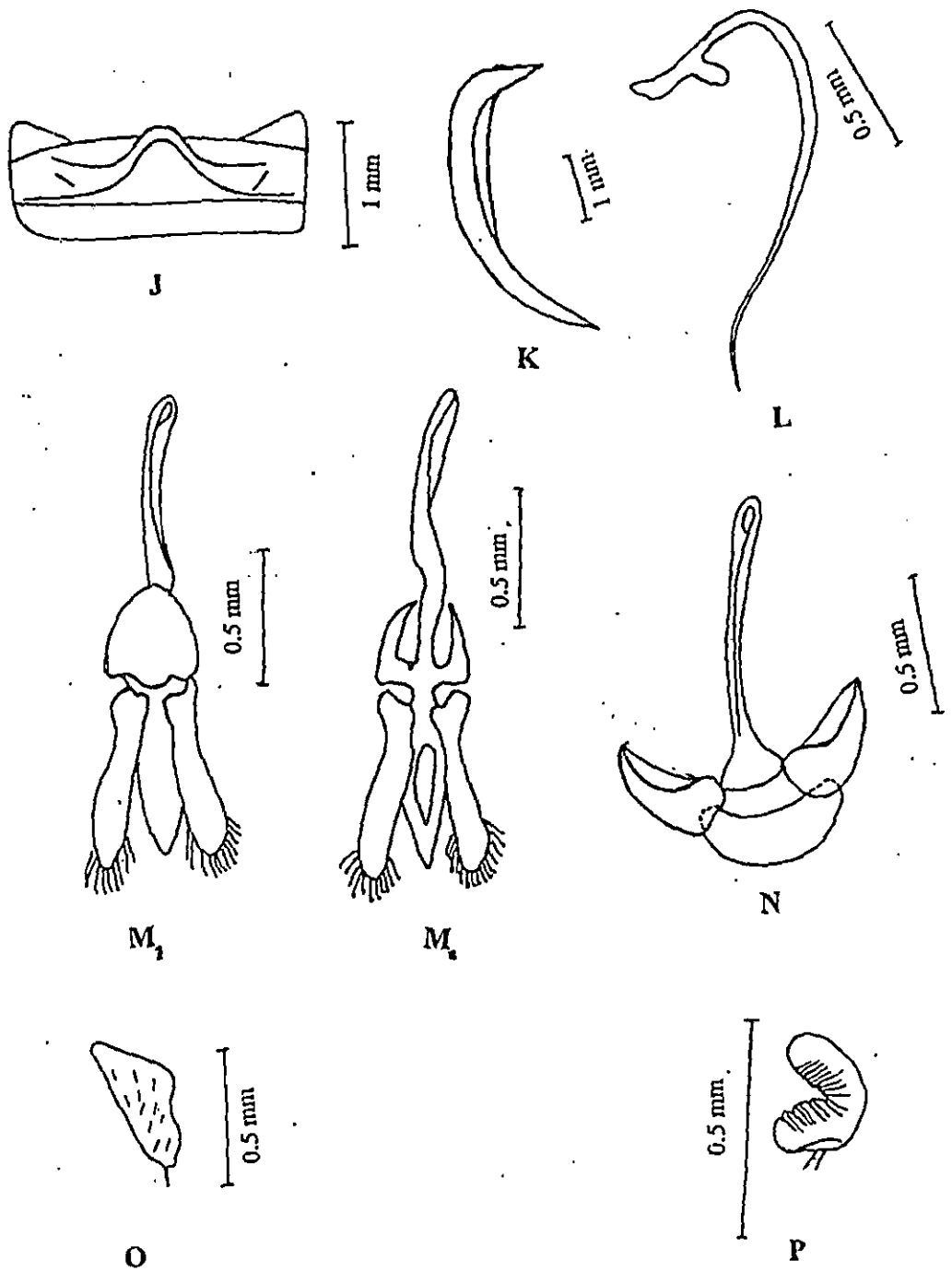


Fig. 2b. ***Cheilomenes sexmaculata***

J. First abdominal sternite showing coxal line and femoral line; K. Epipleura; L. Sipho of male; M_1. Dorsal view of tegmen of male; M_2. Ventral view of tegmen of male; N. Ninth abdominal segment of male; O. Hemisternite of female; P. Spermatheca of female

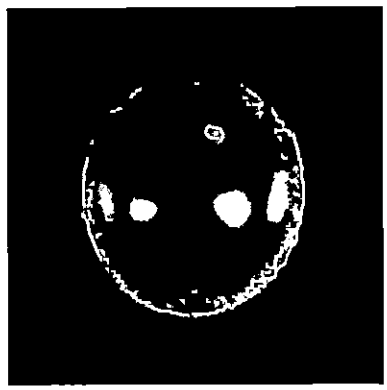


Plate 1

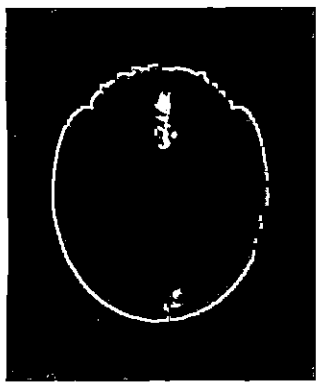


Plate 2a

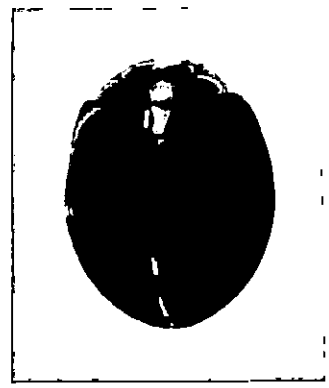


Plate 2b

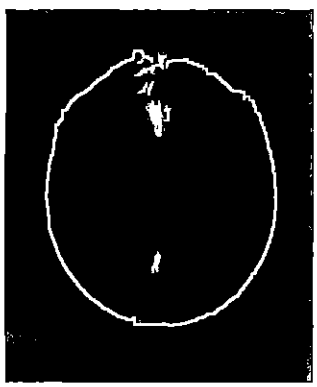


Plate 2c

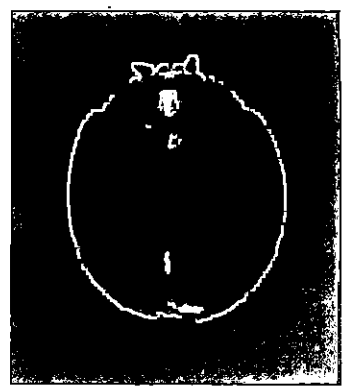


Plate 2d

Plate 1. *Jauravia soror*, Plate 2a, 2b, 2c and 2d. Morphotypes of *Cheilomenes sexmaculata*

tegmen as long as the lateral lobes; caudal end of the apophyses of the ninth abdominal segment with a rounded margin.

Female genitalia: Spermatheca short, stout and slightly curved; base broader.
Measurement (mm): Body length - 3.24 (2.85 to 3.84) , width - 2.8 (2.49 to 3.42)
Material examined: 12 males, 5 females, Vellanikkara, 2002, on *A. craccivora* and *A. gossypii*.

***Harmonia octomaculata* (Fabricius) (Plate 3; Fig. 3a& 3b)**

Coccinella octomaculata Fabricius, 1781: 97
Coccinella arcuata Fabricius, 1787: 55
Harmonia arcuata var. *octomaculata*: Mulsant, 1850: 80
Harmonia arcuata: Mulsant, 1850: 80
Harmonia octomaculata: Mader, 1932: 215

Colouration variable; head black or pale orange with a posterior black spot; pronotum orange or reddish brown with a median black spot or without spot or with three or four spots; scutellum black; elytra including epipleura reddish brown with variable number of black spots; commisural line either black or brown, in pale specimens it is concolourous as the elytra.

Body oval, longer than broad, moderately convex and medium sized; head about 0.2 times as wide as the body, slightly wider than half of pronotum; mouth parts as in Fig. 3; antenna 11 segmented, the terminal segment 1.5 times as broad as the last but one segment; scape nearly quadrilateral, nearly two times as long as wide; pedicel 0.5 times as broad as the scape; pronotum 0.36 times as wide as the body, subangulate at the interior corners; surface of pronotum finely and densely punctate; elytra coarsely and sparsely punctate; coxal line slightly curved and almost reaching the anterior margin; femoral line angulate.

Male genitalia: Median lobe as long as lateral lobes, lateral lobes hairy at the tip; sipho short, basally strongly curved, apical 0.5 straight, apex with a membraneous projection; inner process of siphonal capsule hooked and outer process broadened; apophysis of the ninth abdominal segment abruptly broadened at caudal end.

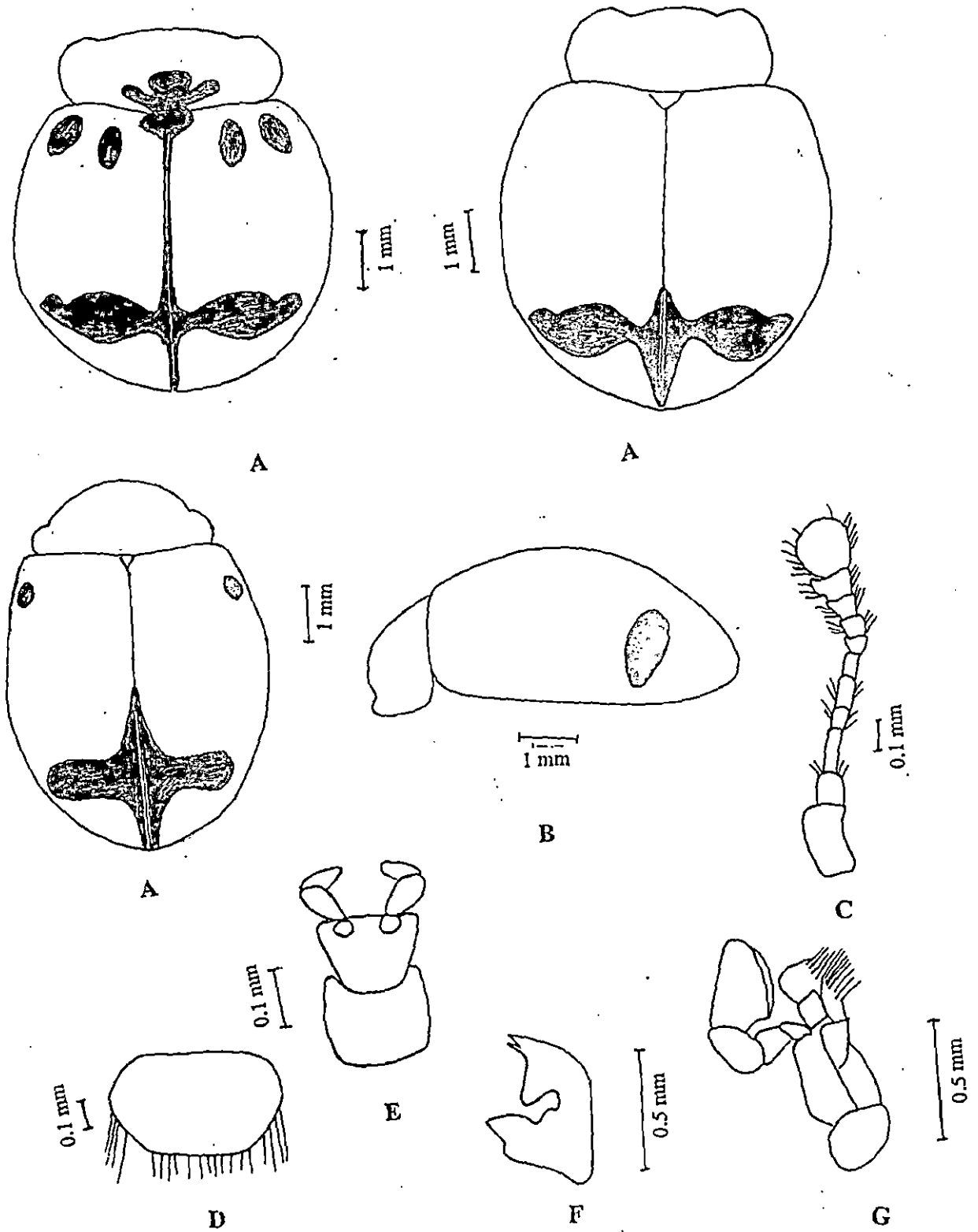


Fig. 3a. ***Harmonia octomaculata***

A. Dorsal view of the beetle; B. Lateral view of the beetle; C. Antenna; D. Labrum E. Labium; F. Mandible; G. Maxilla

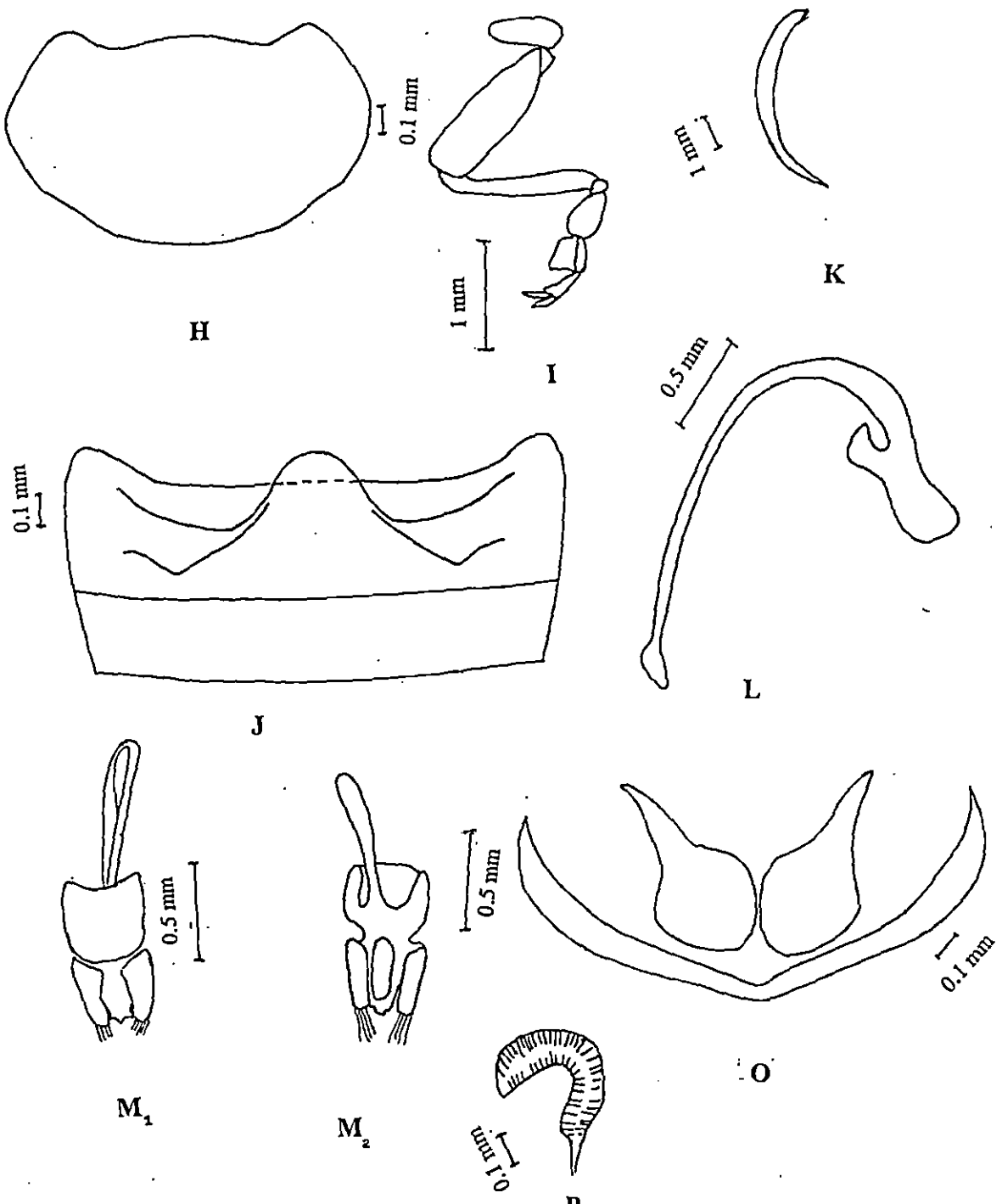


Fig. 3b. ***Harmonia octomaculata***

H. Pronotum; I. Hind leg; J. First abdominal sternite showing coxal line and femoral line; K. Epipleura; L. Sipho of male; M_1. Dorsal view of tegmen of male; M_2. Ventral view of tegmen of male; O. Hemisternite of female; P. Spermatheca of female

Female genitalia: Spermatheca broadly V-shaped of nearly uniform width; hemisternite dumbell shaped, basally broader and rounded, narrow and hairy at the tip.

Measurements (mm): Body length - 3.77 (3.69 to 3.84), width - 2.97 (2.76 to 3.42)

Material examined: 3 males, 2 females; Mannuthy,Thrissur, 2002 ,on *A. craccivora*

Coccinella transversalis Fabricius (Plate 4; Fig.4a& 4b)

Coccinella transversalis Fabricius, 1781: 97. - Pope, 1989: 652 (rev.)

Coccinella repanda Thunberg, 1781: 18. - Mulsant, 1850: 1022 (Syn.). - Pope, 1987: 62 (rev.)

Head black with yellow to brown spot along inner ocular margin; mouth parts black; pronotum black with anterior lateral areas yellow; scutellum black; elytra yellow, orange or red with variable black markings; commissural line always black.

Body oval, medium sized, dorsum strongly convex; head 0.36 times as wide as the body; frons punctate with few long setae; anterior margin of clypeus straight; inner ocular margins straight; mouth parts as in Fig.4; antenna 11 segmented, clavate, distal segment truncate; pronotum 0.68 times as wide as the body, very finely, sparsely punctate; elytra sparsely densely, punctate; epipleuron of moderate size; coxal line complete; femoral line angulate.

Male genitalia: Sipho short, inner process of siphonal capsule elongate and curved, apex of sipho twisted; median lobe of tegmen as long as the lateral lobes; apophysis of the ninth abdominal segment bilobed.

Female genitalia: Spermatheca strongly curved, hooked and basally broad.

Measurements (mm): Body length - 3.9 (3.84 to 4.02), width - 3 (2.94 to 3.06)

Materials examined: 8 males, 4 females, Vellanikkara,Thrissur, 2002, on *A. craccivora*

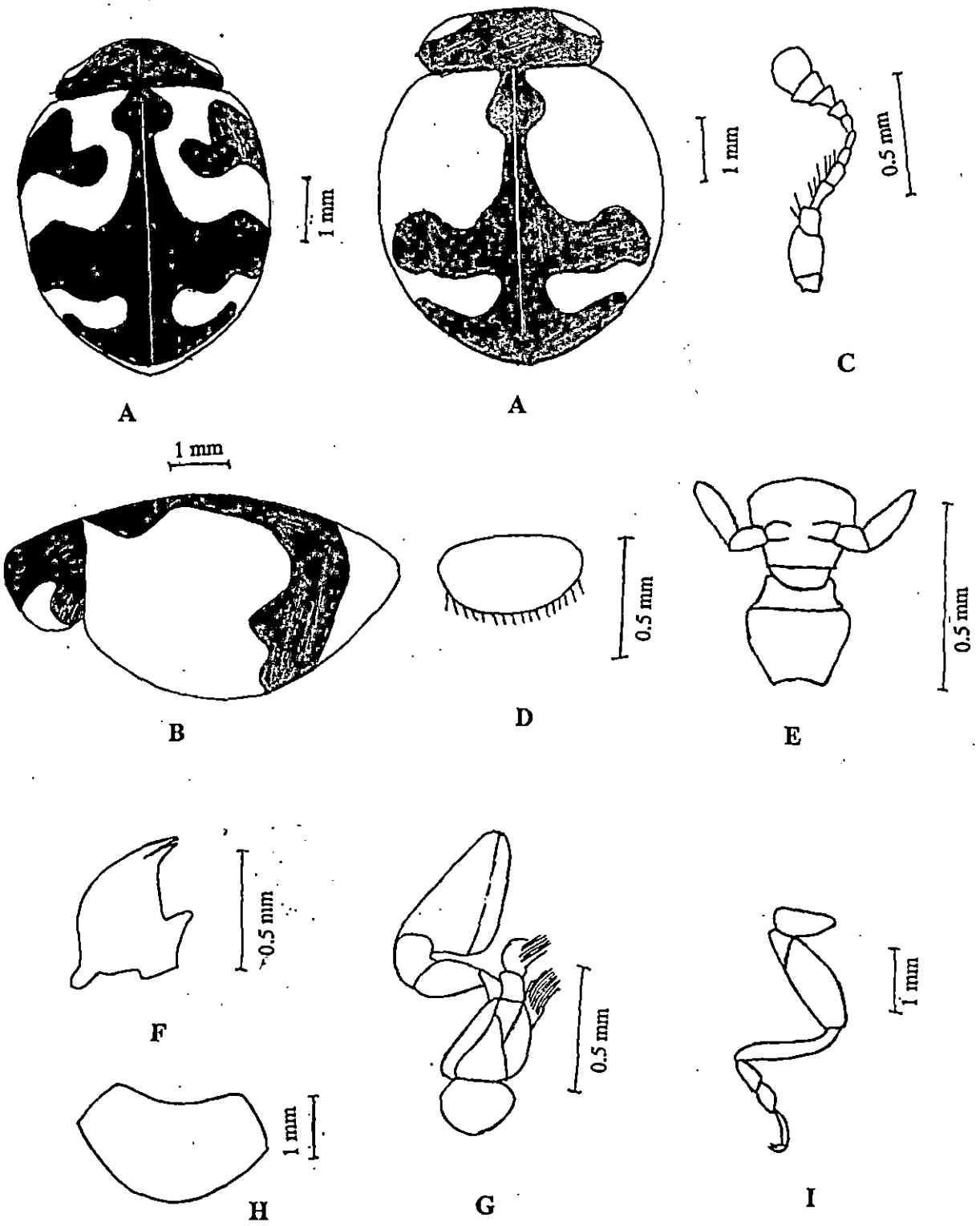


Fig. 4a. ***Coccinella transversalis***

A. Dorsal view of the beetle; B. Lateral view of the beetle; C. Antenna; D. Labrum E. Labium; F. Mandible; G. Maxilla; H. Pronotum; I. Hind leg

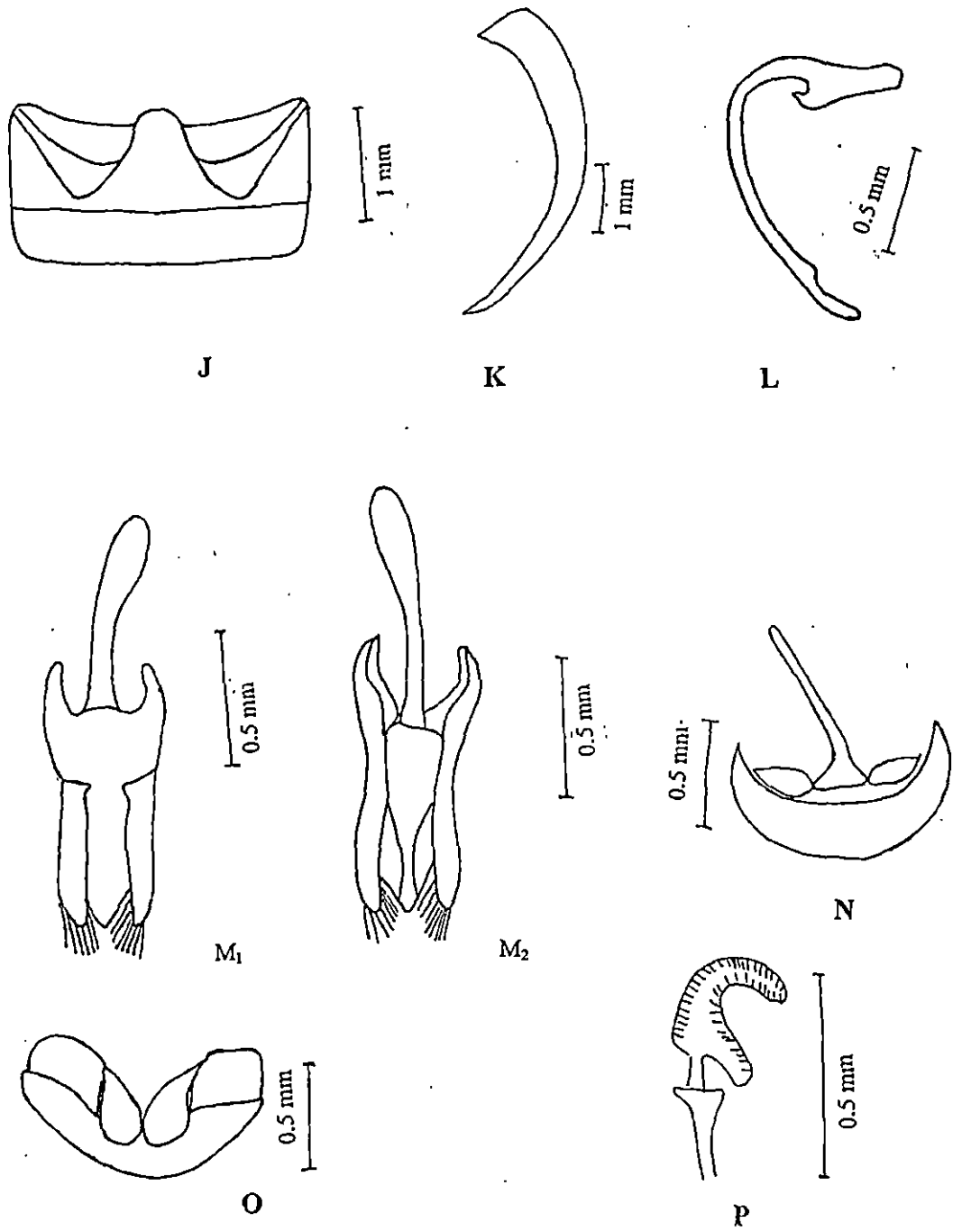


Fig. 4b. ***Coccinella transversalis***

J. First abdominal sternite showing coxal line and femoral line; K. Epipleura; L. Sipho of male; M_1. Dorsal view of tegmen of male; M_2. Ventral view of tegmen of male; N. Ninth abdominal segment of male; O. Hemisternite of female; P. Spermatheca of female

Micraspis discolor Fabricius (Plate 5;Fig. 5a& 5b)

Coccinella discolor Fabricius, 1798: 77
Verania discolor Mulsant, 1850: 369
Micraspis discolor : Kamiya, 1965: 60. - Sasaji, 1968

Head yellow, often with a large median black spot; compound eyes black; mouth parts brown; pronotum yellow laterally, medially black; scutellum black; elytra orange brown with black commissural line, anterior 0.25 much wider, lateral margin fiscous; front legs yellowish brown; mid and hind coxae black; venter black.

Body elongate oval, dorsum convex, glabrous and medium sized; head 0.36 times as wide as the body, finely, densely pitted; inner ocular margin curved; mouth part as in Fig. 5; antenna 11 segmented long, last three segments gradually enlarging; elytra finely punctate, punctures dense compared to pronotum; epipleura well developed; coxal line almost straight and complete; femoral line straight and incomplete.

Male genitalia: Sipho curved at basal 0.33, apical 0.67 nearly straight; siphonal capsule well developed, siphonal tip spatulate with hooked process; tegmen long, the lateral lobes longer than median lobes.

Female genitalia: Spermatheca curved; C-shaped.
Measurements (mm): Body length - 2.79 (2.67 to 3.06), width - 2.3 (2.19 to 2.46)
Materials examined: 7 males, 3 females, Mannuthy,Thrissur, 2002, on *A. craccivora*

Anegleis cardoni (Weise) (Plate 6;Fig.6a & 6b)

Verania cardoni Weise, 1892: 19
Coelophora cardoni: Gorham, 1894a: 202
Micraspis cardoni: Timberlake, 1943: 27
Anegleis cardoni: Iablokoff - Khnzorian, 1982: 295

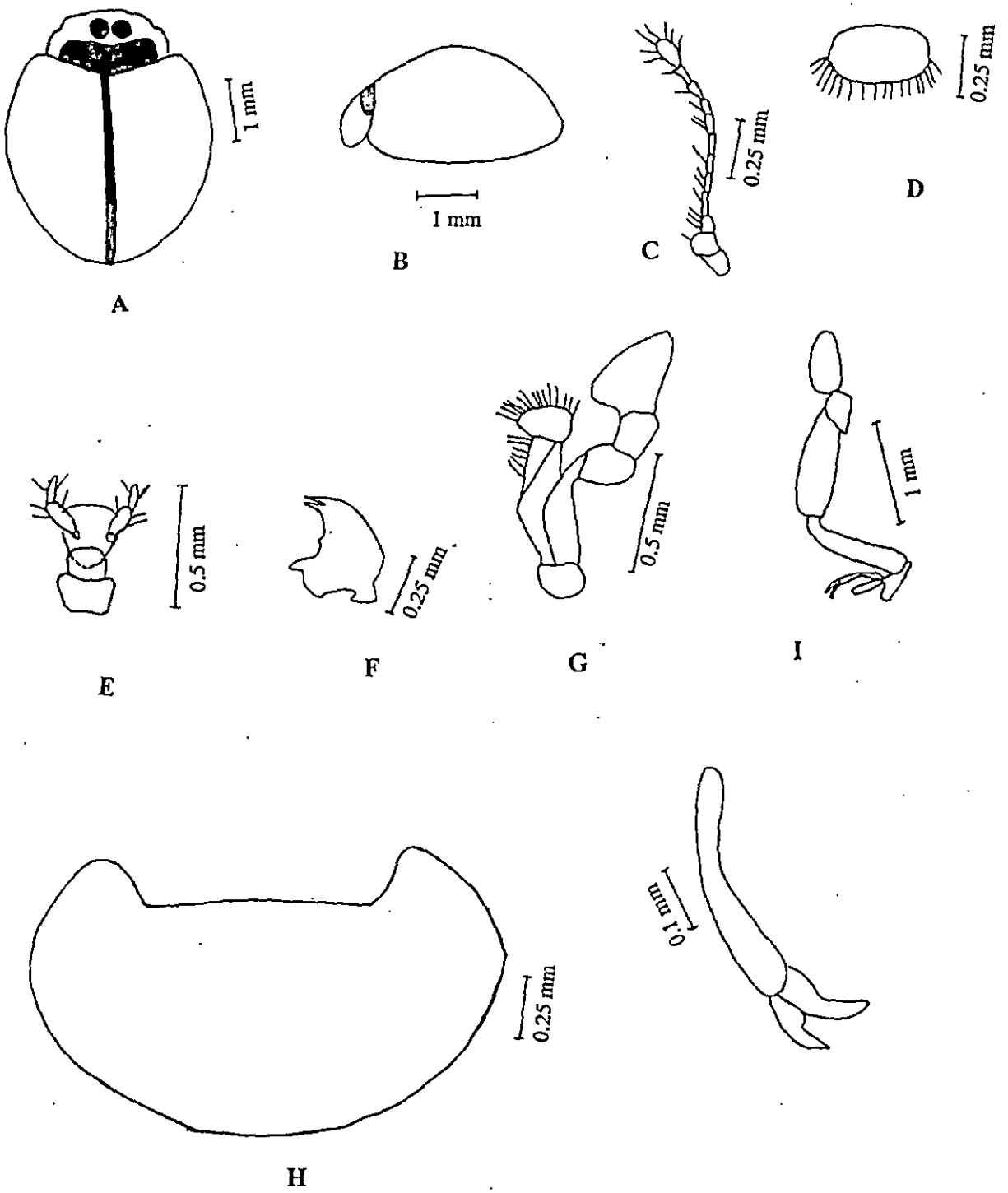


Fig. 5a. ***Micraspis discolor***

A. Dorsal view of the beetle; B. Lateral view of the beetle; C. Antenna; D. Labrum
E. Labium; F. Mandible; G. Maxilla; H. Pronotum; I. Hind leg

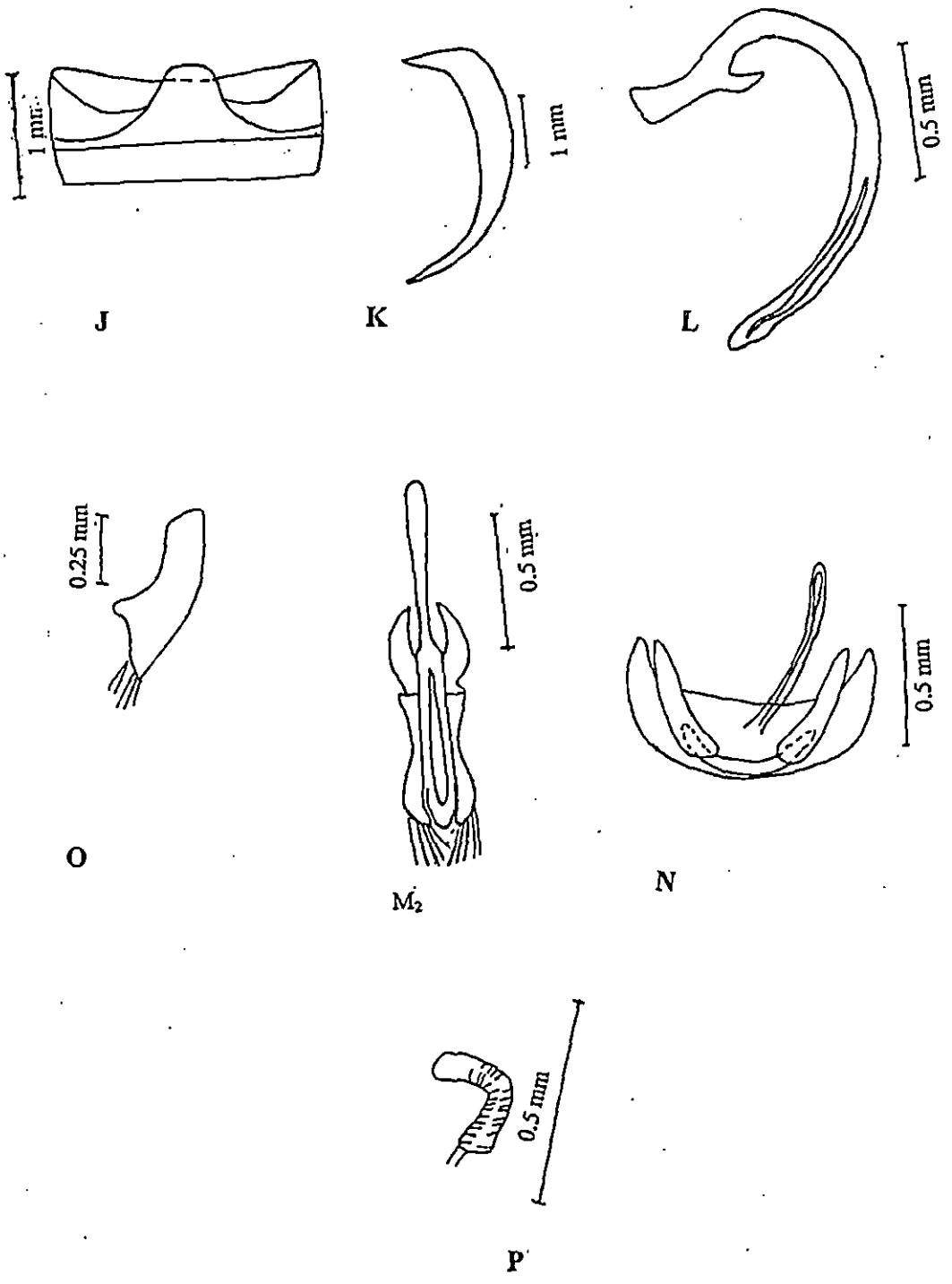


Fig. 5b. *Micraspis discolor*

J. First abdominal stemite showing coxal line and femoral line; K. Epipleura; L. Sipho of male; M_2. Ventral view of tegmen of male; O. Hemistemite of female; P. Spermatheca of female; N. Ninth abdominal segment of male

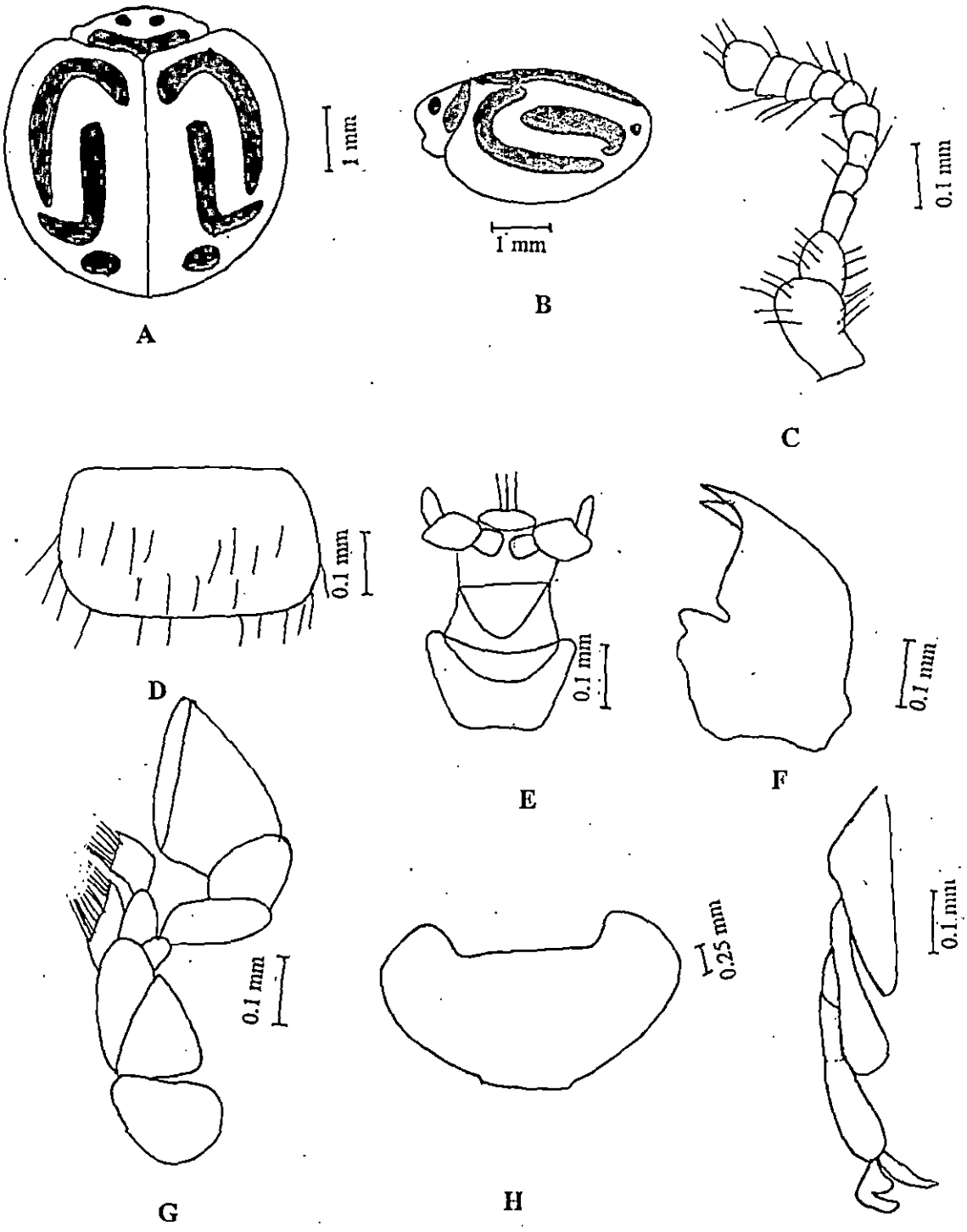


Fig. 6a. ***Anegleis cardoni***

A. Dorsal view of the beetle; B. Lateral view of the beetle; C. Antenna; D. Labrum; E. Labium; F. Mandible; G. Maxilla; H. Pronotum; I. Hind leg

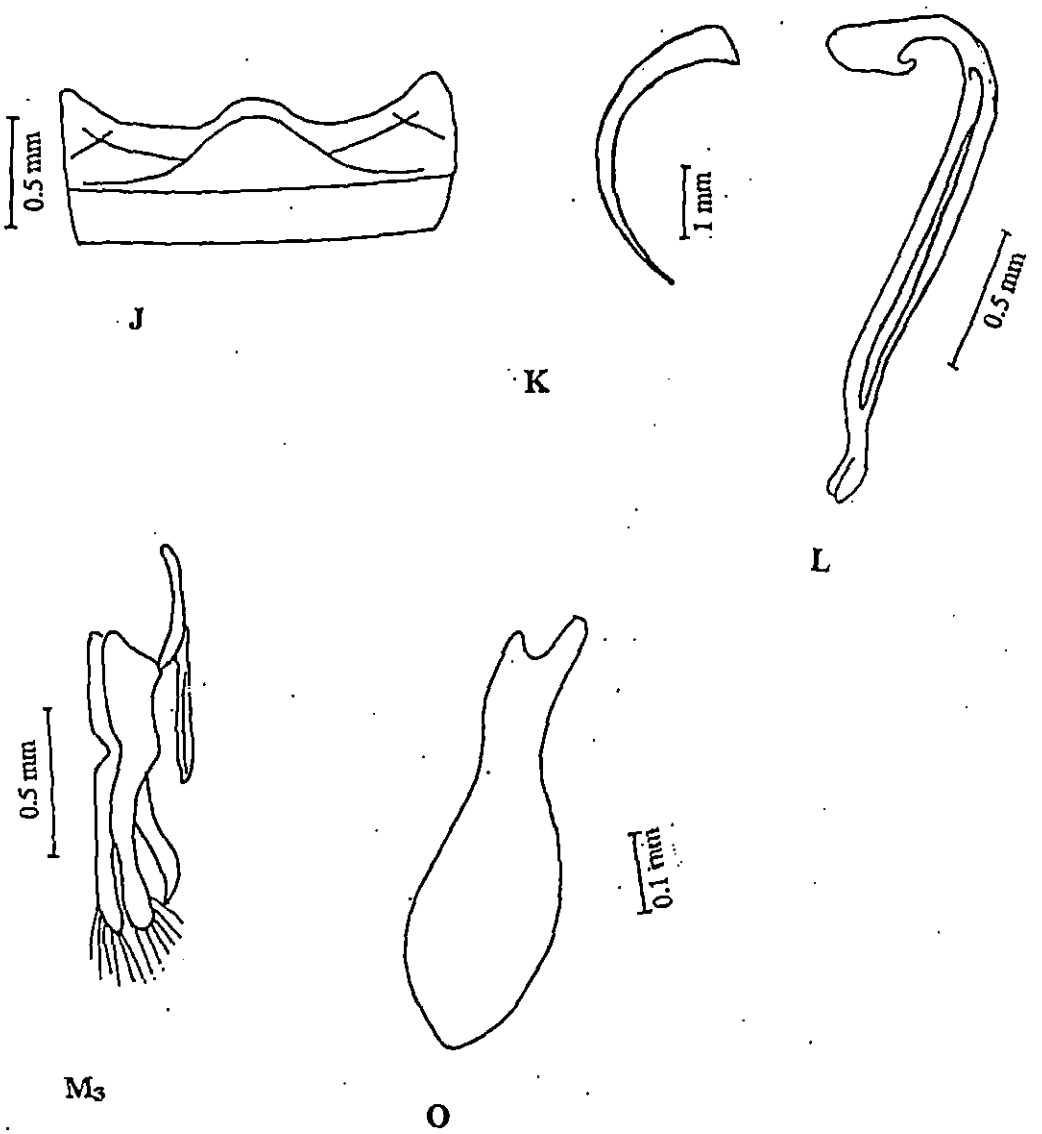


Fig. 6b. *Anegleis cardoni*

J. First abdominal sternite showing coxal line and femoral line; K. Epipleura; L. Sipho of male; M_3. Lateral view of tegmen of male; O. Hemisternite of female

Head yellowish brown; compound eyes black; mouth parts dark brown; pronotum orange yellow with two median discal spots and posterior marginal transverse band (medially constricted) black; scutellum orange yellow with black margins; elytra orange yellow with black commissural line, two black J-shaped stripes arranged as in Fig. 6a ; venter and legs brown.

Body round, dorsally convex, glabrous and medium sized: head finely, sparsely, punctate: mouth parts as in Fig. 6 : antenna 11 segmented: pronotum 0.55 times as wide as the body, finely, sparsely punctate, lateral lobes projected anteriorly:; elytra finely, sparsely punctate, epipleura well developed; coxal line slightly curved and complete; femoral line straight and almost reaching the lateral margin.

Male genitalia: Sipho slightly curved in anterior 0.25; siphonal capsule well developed; inner process slightly curved inwards, apex of sipho with bilobed membranous structure, lateral lobes of tegmen longer than the median lobe, median lobe flattened, much broadened apically.

Female genitalia: Hemisternite is bottle shaped, with bifid apical end

Measurements (mm): Body length - 3.06(3.03 - 3.15), width - 2.5(2.4- 2.55)

Materials examined:1 male, 1 female, Vellanikkara, Thrissur, 2002, on *A. craccivora*

Sub Family: Chilocorinae

Antenna usually reduced in length and number of segments; terminal segment of maxillary palpi usually nearly parallel-sided, never strongly divergent apically; anterior margin of pronotum very deeply and horizontally concave, lateral portions of pronotum very strongly descending below; elytral base distinctly broader than pronotal base; elytral epipleura relatively broad, its inner carina reaching the elytral apex.

Tribe: Chilocorini

Dorsum glabrous, rarely pubescent; femora normal, not strongly depressed and not compactly plugged into fovae of underside: abdomen composed

Plate 3

Plate 4a

Plate 4b

Plate 5

Plate 6

Plate 3. *Harmonia octomaculata*,
Plate 4a and 4b. *Coccinella transversalis*
Plate 5. *Micraspis discolor*, Plate 6. *Anegleis cardoni*

of five visible segments in female and six in male but sixth of male is very shortly visible in external aspect, rarely invisible; tarsi always cryptotetramerous.

Only one species *Brumoides suturalis* belonging to the tribe Chilocorini was studied.

***Brumoides suturalis* (Fabricius) (Plate 7; Fig.7)**

Coccinella suturalis Fabricius, 1798: 78
Brumus suturalis : Mulsant, 1850: 494
Brumoides suturalis: Chapin, 1965a: 237

Head and thorax reddish brown, eyes black; pronotum yellowish brown, scutellum black; elytra yellow, commissural line except the apical 0.14 length, broadly black, a broad longitudinal stripe on each elytron black.

Body oval, longer than broad, moderately convex above; head 0.35 times as wide as the body, sparsely finely punctate; from each punctation a hair arises; mouth parts as in Fig. 7; pronotum 0.63 times as wide as the body anteriorly produced lateral lobes; surface sparsely, finely punctate; elytra finely, sparsely, punctate, a sub marginal row of punctures on lateral aspects more prominent; coxal line complete.

Male genitalia: Sipho strongly curved in basal 0.3, apical 0.66 rather straight, broadened apically; siphonal capsule with inner process slender, long quadrate, outer process stout, quadrate; tegmen with median lobe half as long as lateral lobes; lateral lobes parallel sided; apophysis of the ninth segment caudally bifid.

Female genitalia: Spermatheca strongly curved, robust with a W-shaped inner margin.

Measurements (mm): Body length - 2.22 (2.48 to 2.82), width - 1.95 (1.62 to 2.55).
Materials examined: 4 males, 8 females, Mannuthy,Thrissur, 2002, on *A. craccivora*

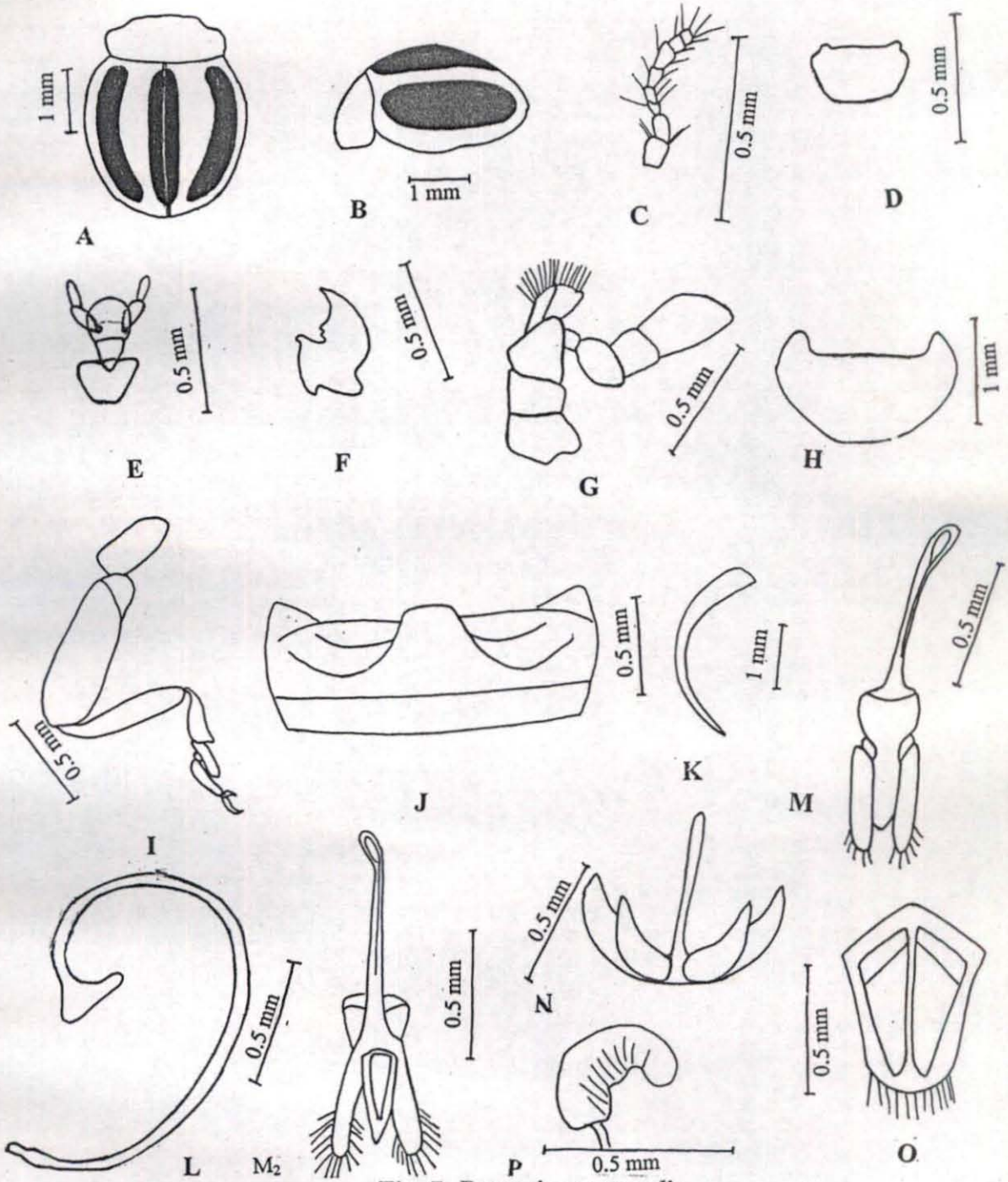


Fig. 7. *Brumoides suturalis*

A. Dorsal view of the beetle; B. Lateral view of the beetle; C. Antenna; D. Labrum; E. Labium; F. Mandible; G. Maxilla; H. Pronotum; I. Hind leg; J. First abdominal sternite showing coxal line and femoral line; K. Epipleura; L. Sipho of male; M_1. Dorsal view of tegmen of male; M_2. Ventral view of tegmen of male; N. Ninth abdominal segment of male; O. Hemisternite of female; P. Spermatheca of female

Subfamily: Scymninae

Body usually small and some times medium sized; dorsum pubescent except in Hyperaspini; pronotum and elytra compactly articulated; terminal segment of maxillary palpi not strongly securiform; mentum relatively broadly articulated with submentum; pronotum not deeply concave at anterior margin; middle coxae usually broadly separated; elytral epipleura narrow and short; tarsi cryptotetramerous or trimerous.

Tribe: Aspidimerini

Small, pubescent; antennae small, exposed at the base, geniculate, nine segmented, first segment large, broadly quadrate or ovate, second a little smaller and subtriangular, the last seven segments together forming a spindle or club shaped flagellum; abdomen with six visible sternites, the first being dilated posteriorly in an arc in the middle; legs with the trochanter elongate, femora broadly expanded and completely concealing the compressed tibiae, tarsi three segmented, the usually small, third penultimate segment absent, claws pointed each with a subquadrate basal tooth.

In the tribe Aspidimerini only one species was studied by the author.

***Pseudaspidimerus trinotatus* (Thunberg) (Plate 8;Fig. 8a& 8b)**

Coccinella trinotata Thunberg, 1781: 11
Pseudaspidimerus circumflexa: Kapur 1948c: 117
(rev.) - Synonymised by Pope, 1987: 64
Pseudaspidimerus trinotatus: Pope, 1987: 64

Body subrounded convex; head finely and sparsely punctate in male and comparatively closely punctate in female, pubescence greyish, short and sparse in both sexes; clypeus, antennae and mouth parts brown; elytra entirely testaceous or moderately dark brown; punctation moderately fine and fairly close; pubescence greyish, fairly long and dense; pronotum moderately finely and closely punctate and with greyish fairly long and dense pubescence; the last abdominal sternite in male fairly deeply emarginate posteriorly.

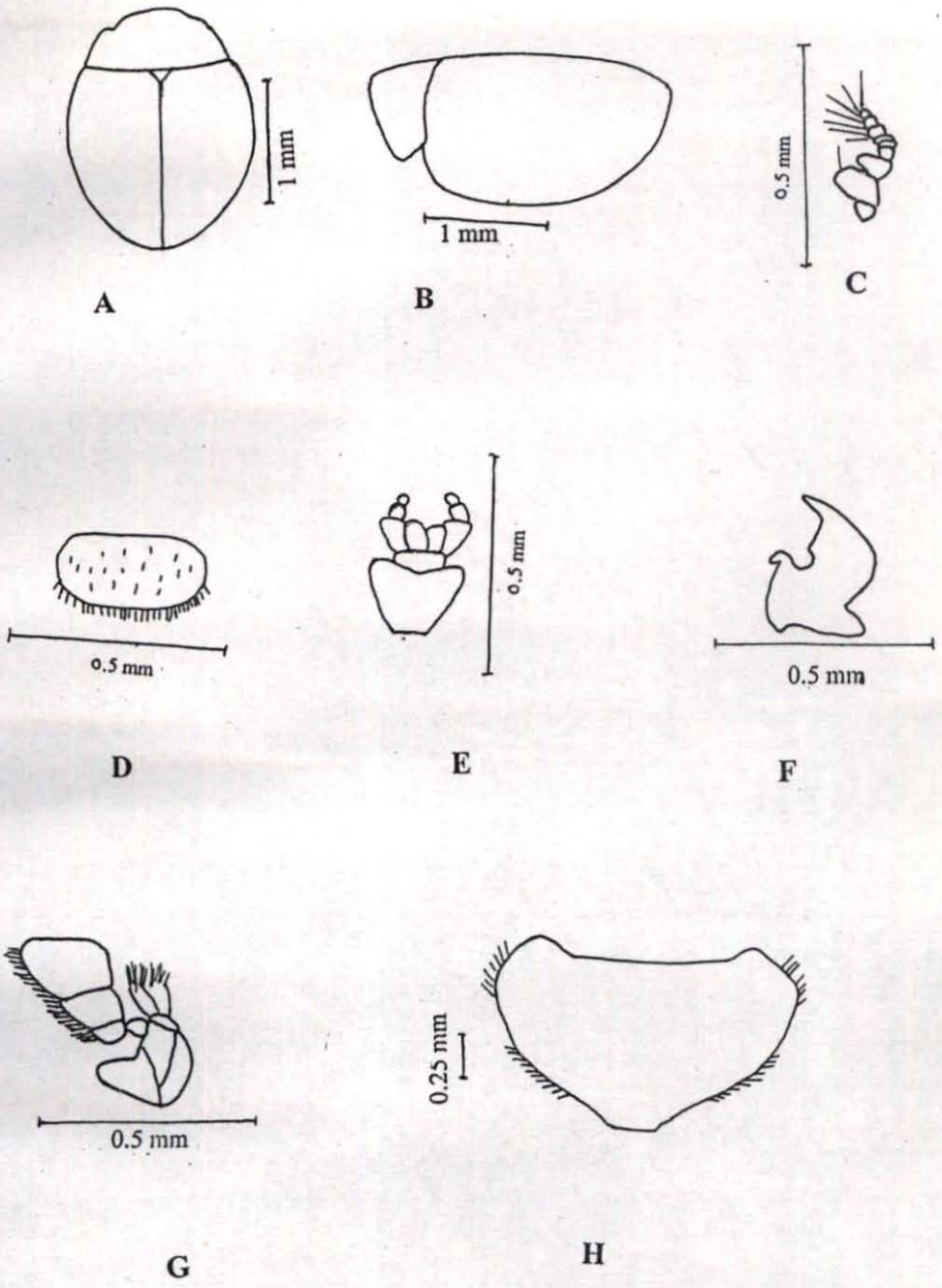


Fig. 8a. ***Pseudaspidimerus trinotatus***

A. Dorsal view of the beetle; B. Lateral view of the beetle; C. Antenna; D. Labrum; E. Labium; F. Mandible; G. Maxilla; H. Pronotum

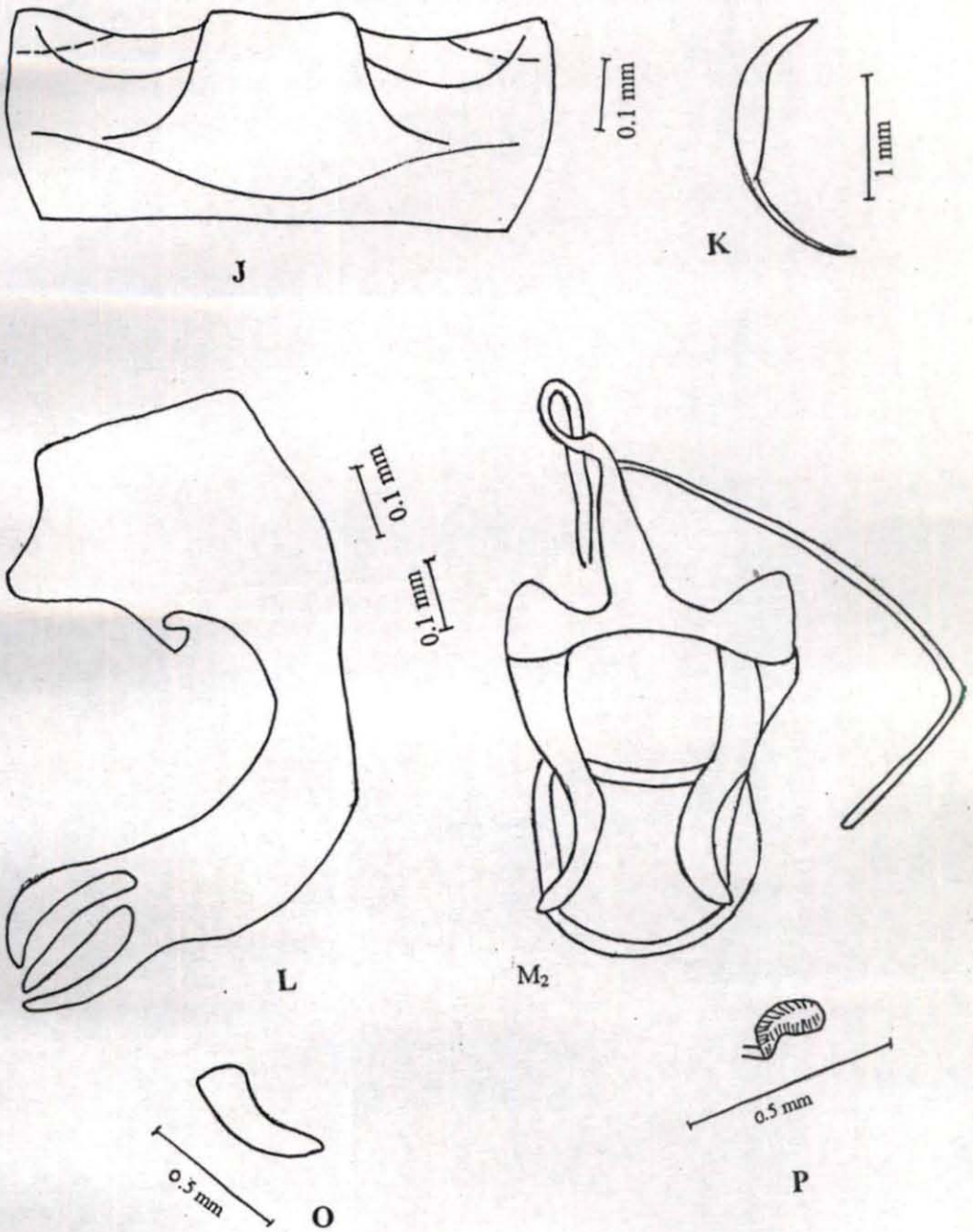


Fig. 8b. ***Pseudaspidimerus trinotatus***

J. First abdominal sternite showing coxal line and femoral line; K. Epipleura; L. Sipho of male; M_2. Ventral view of tegmen of male; O. Hemisternite of female; P. Spermatheca of female

Male genitalia: Siphonal capsule, though swollen not forming a bulb; siphonal tip as in Fig. 8; penis nearly as broad as long with paramere filiform, slightly bent before the middle.

Female genetalia: Spermatheca strongly bent near the base; ninth sternite nearly quadrate.

Measurements (mm): Body length 1.86 (1.59 to 2.01), width - 1.48 (1.32 to 1.56)

Materials examined: 8 males, 4 females, Vellanikkara, Thrissur, 2002,on *A. craccivora*

Tribe: Scymnini

Body small, less than 4 mm; rarely medium sized, elongate oval to hemispherical; dorsum always distinctly pubescent; antenna eight to eleven segmented and rather short; terminal segment of maxillary palps not distinctly convergent, not strongly divergent apically but nearly parallel sided or weakly divergent apically; elytral epipleura very narrow without distinct fovae for the reception of the tip of femora; tarsi trimerous or cryptotetramerous; tegmen of male genitalia usually not very much slender; hemisternites of female elongate, triangular to transverse oval, usually provided with a distinct stylus.

Three species belonging to Scymnini was studied.

Key to the species under the tribe Scymnini

1. Elytra brownish orange with dark brown patches and spots; outer process of siphonal capsule broader and longer than inner process (Fig. 9: L) . . . . . ***S. (P.) coccivora***

   Elytra black with orange patch; sipho not as above 2

2. Elytra black with apical 0.25orange; sipho with small finger like projection at basal area and a thread like process at apex (Fig. 10b: L) . . ***S. (P.) pyrocheilus***

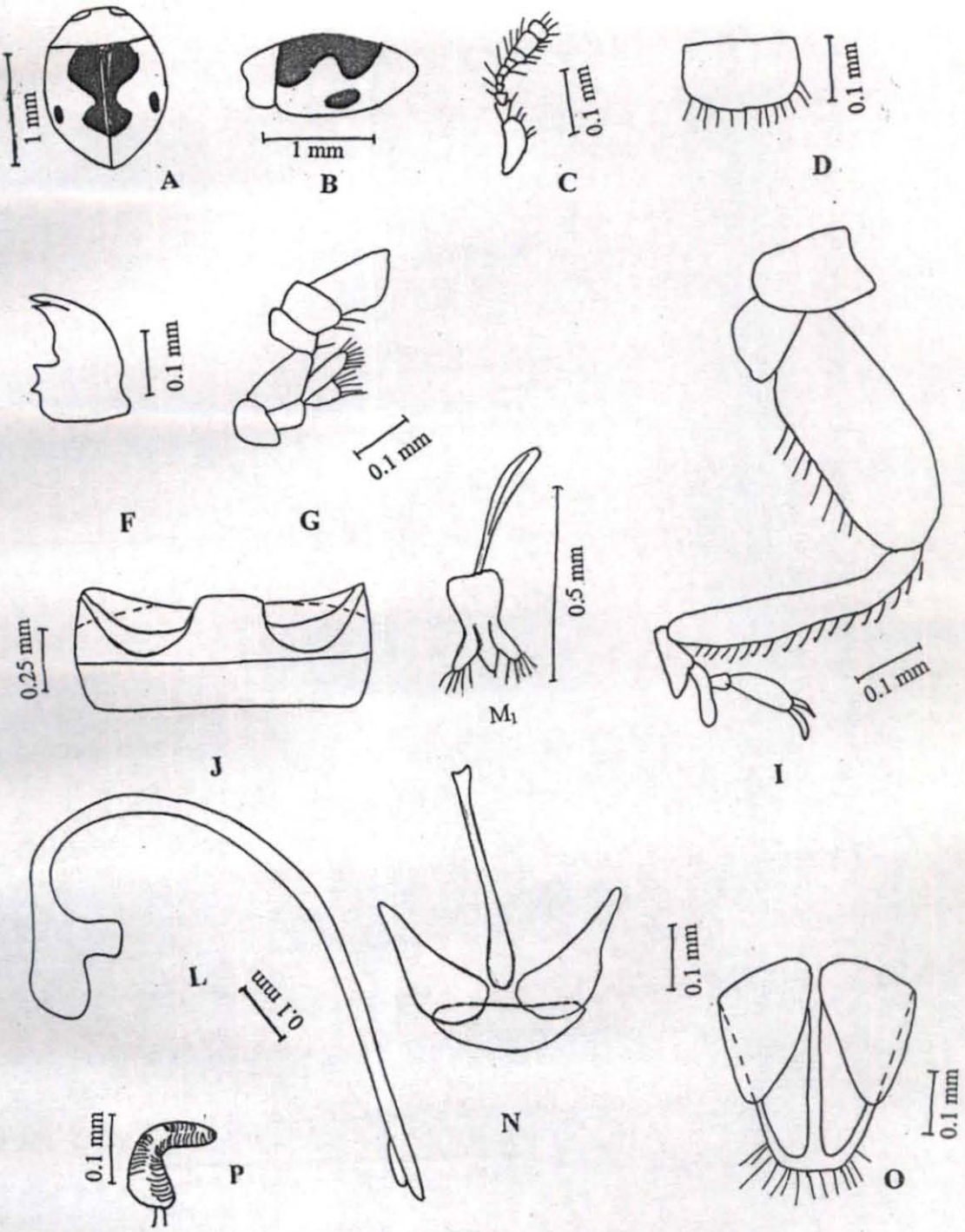


Fig. 9. *Seymnus* (*Pullus*) *coccivora*

A. Dorsal view of the beetle; B. Lateral view of the beetle; C. Antenna; D. Labrum; F. Mandible; G. Maxilla; I. Hind leg; J. First abdominal sternite showing coxal line and femoral line; L. Sipho of male; M_1. Dorsal view of tegmen of male; N. Ninth abdominal segment of male; O. Hemisternite of female; P. Spermatheca of female

Elytra black with two nearly rectangular orange patch; sipho with small notch near the middle (Fig. 11: L)..... ..... ***S. (P.) latemaculatus***

***Scymnus (Pullus) coccivora* Ayyar(Plate 9; Fig. 9)**

Scymnus coccivora Ayyar, 1925: 491
Scymnus (Pullus) coccivora: Korschefsky, 1931: 142

Head yellowish brown, mouth parts dark brown; prothorax yellowish brown with dark brown patch at the median dorsal region; scutellum brown; elytra yellowish brown with characteristically arranged dark brown markings (Fig 8a:A).

Body elongate oval, strongly convex above, pubescent, small sized; head 0.48 times as wide as the body, finely sparsely punctate; antenna 11 segmented, clubbed, last segment less than half as long as the last but one segment; prothorax 0.78 times as wide as the body, finely sparsely punctate, slightly pointed anteriorly; elytra coarsely sparsely, punctate, pubescent, epipleura weakly developed; coxal line slightly curved and complete; femoral line deeply curved and complete.

Male genitalia: Sipho curved at basal 0.67, apical 0.33 almost straight, apically pointed outer process of the siphonal capsule broader and longer than the inner process, lateral process of tegmen as long as the median process, apophysis of ninth abdominal segment broadened basally.

Female genitalia: Spermatheca broadly V- shaped and basally curved
Measurement (mm): Length - 1.28 (1.17 to 1.41), width - 0.9 (0.84 to 0.96)
Materials examined: 7 males and 4 females, Vellanikkara, Thrissur, 2002, on *C. insolitus*

***Scymnus (Pullus) pyrocheilus* Mulsant (Plate 10; Fig. 10a & 10b)**

Scymnus pyrocheilus Mulsant, 1835a: 281
Scymnus (Pullus) pyrocheilus: Mulsant, 1853b: 153

Head black, mouthparts dark brown; prothorax black; elytra black with apical and marginal 0.25 orange.

Body elongate oval, strongly convex above, pubescent, small sized; head 0.33 times as long as the body; antenna eleven segmented, scape 0.5 times as wide as long; pronotum anterior and lateral portion yellowish, slightly pointed anteriorly; elytra discally black, laterally orangish yellow, apical 0.25 yellow or orange, densely hairy, with short white hairs; epipleura weakly developed; coxal line slightly curved and complete; femoral line deeply curved and complete.

Male genitalia: Sipho curved at basal 0.67 with thread like process, apical end with small finger like process; lateral process of tegmen slightly longer than median process.

Female genitalia: Spermatheca slightly curved at tip, basally broader

Measurements (mm) : Body length - 1.56 (1.44 to 1.65), width - 1.06 (0.96 to 1.11)

Materials examined: 6 males, 1 female, Vellanikkara, Thrissur, 2002, on *A. gossypii*

Scymnus (Pullus) latemaculatus Motschulsky(Plate 11; Fig. 11)

Scymnus (Pullus) latemaculatus Motschulsky,1858:121
Scymnus quadrillum auctt: Kapur, 1942: 61

Body elongate oval, small sized; head yellowish brown; mouthparts dark brown; prothorax yellowish brown; elytra black with two nearly rectangular orange patches, densely hairy, punctate; epipleura narrow; antenna ten segmented, last two segments nearly equal in length; prothorax 0.5 times as long as wide, coarsely, finely punctate, hairy; coxal line slightly curved and complete; femoral line deeply curved and complete.

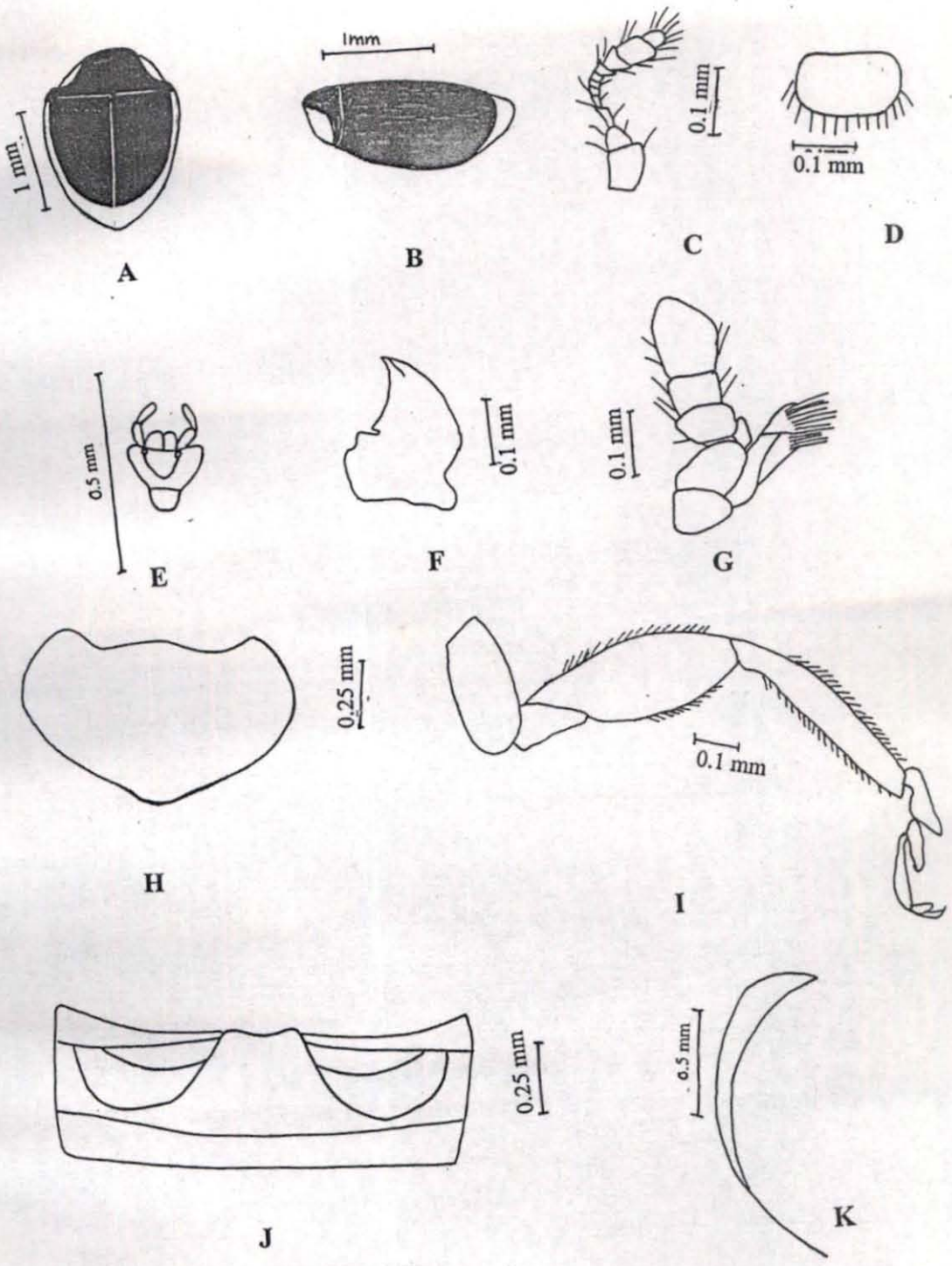


Fig. 10a. *Seymnus* (*Pullus*) *pyrocheilus*

A. Dorsal view of the beetle; B. Lateral view of the beetle; C. Antenna; D. Labrum; E. Labium; F. Mandible; G. Maxilla; H. Pronotum; I. Hind leg; J. First abdominal sternite showing coxal line and femoral line; K. Epipleura

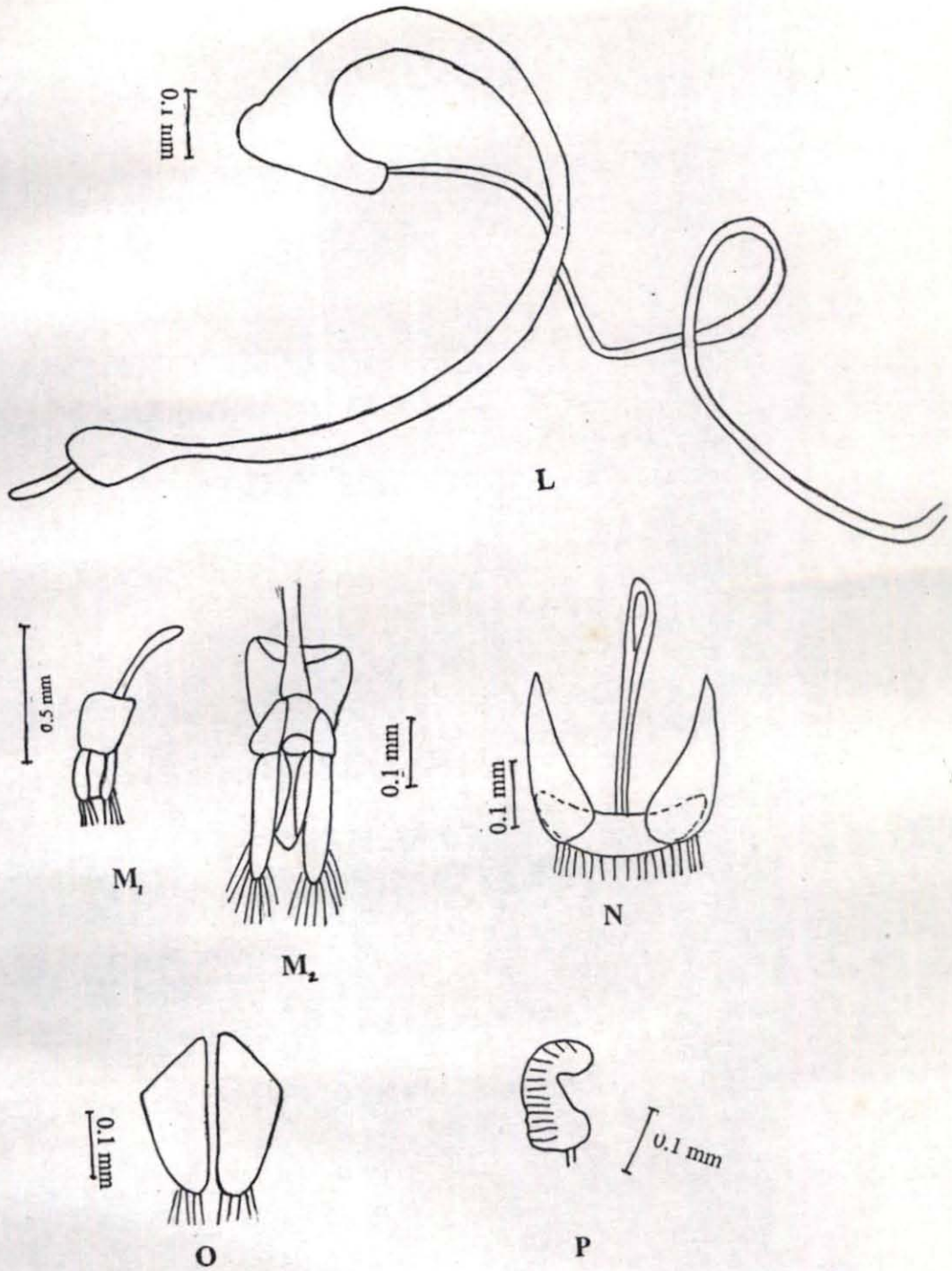


Fig. 10b. ***Seymnus* (*Pullus*) *pyrocheilus***

L. Sipho of male; M_1. Dorsal view of tegmen of male; M_2. Ventral view of tegmen of male; N. Ninth abdominal segment of male; O. Hemisternite of female; P. Spermatheca of female

Plate 7

Plate 8

Plate 9

Plate 10

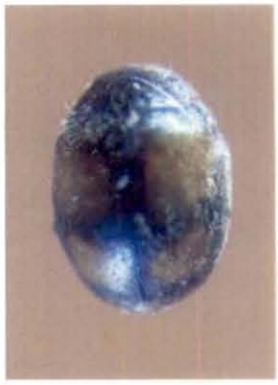


Plate 11

Plate 7. *Brumoides suturalis*
Plate 8. *Pseudaspidimerus trinotatus*, Plate 9. *Scymnus (Pullus) coccivora*
Plate 10. *Scymnus (Pullus) pyrocheilus*, Plate 11. *Scymnus (Pullus) latemaculatus*

Male genitalia: Sipho slightly curved at basal 0.67, apical 0.33 almost straight with a notch like process; median process of tegmen slightly longer than lateral processes.

Female genitalia: Hemisternite nearly triangular, hairy at apex.

Measurements (mm): Body length - 1.42 (1.38 to 1.55), width 1.08 (1.05 to 1.14)

Materials examined: 3 males, 2 females, Vellanikkara, Thrissur, 2002, *A. craccivora*

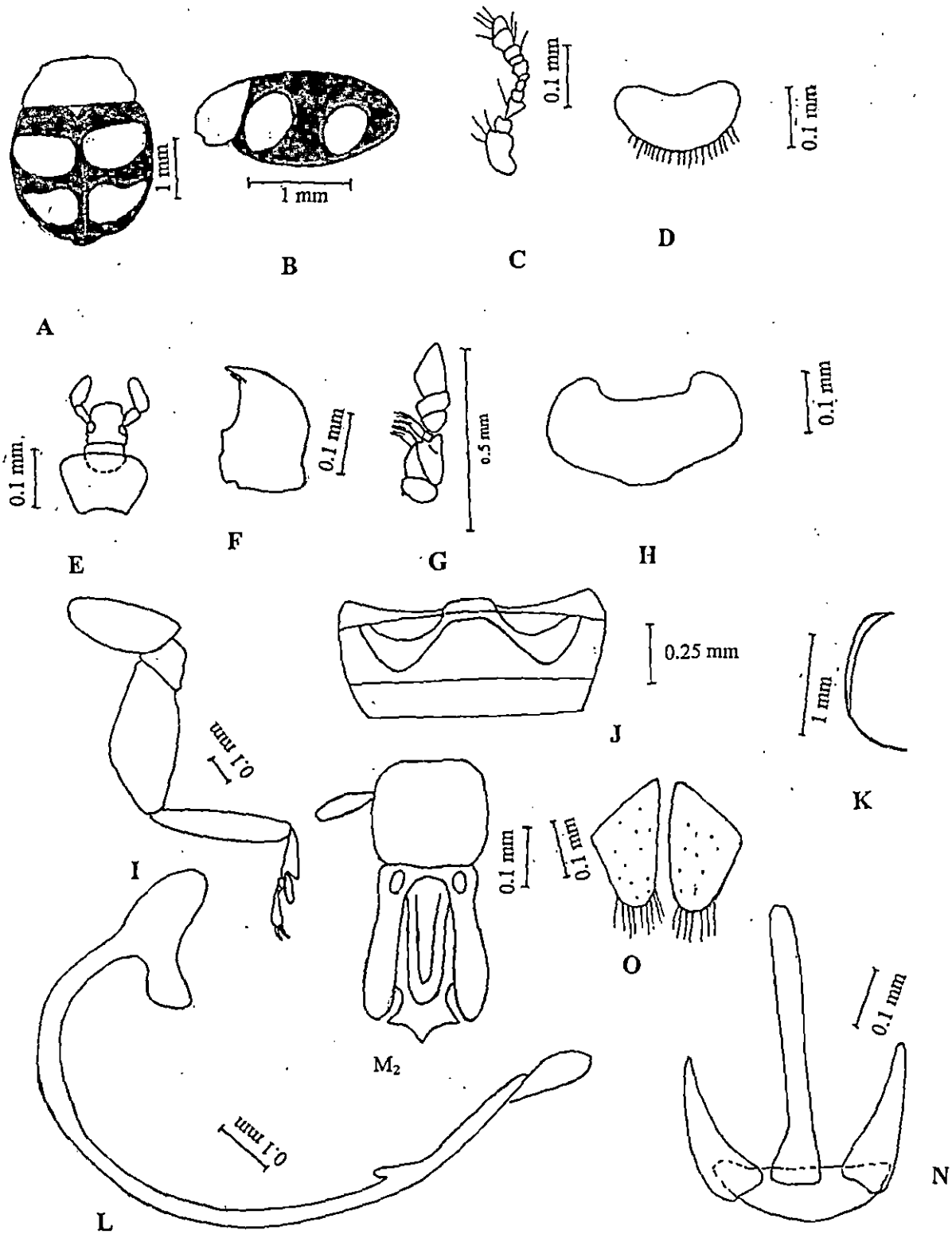


Fig. 11. ***Seymnus* (*Pullus*) *latemaculatus***

A. Dorsal view of the beetle; B. Lateral view of the beetle; C. Antenna; D. Labrum; E. Labium; F. Mandible; G. Maxilla; H. Pronotum; I. Hind leg; J. First abdominal sternite showing coxal line and femoral line; L. Sipho of male; N. Ninth abdominal segment of male; O. Hemisternite of female .

Discussion

5. DISCUSSION

The family Coccinellidae of the order Coleoptera consists of six subfamilies, namely, Scymninae, Coccinellinae, Sticholotidinae, Chilocorinae, Coccidulinae and Epilachninae. Except Epilachninae, members of all other subfamilies are predaceous in nature. Lady bird beetles of the Indian subcontinent (excluding Epilachninae) comprises of 400 species in 79 genera, 22 tribes and five subfamilies. The major subfamilies are Scymninae and Coccinellinae, consisting of 137 and 118 species, respectively and forming 63.75 per cent of the total fauna. These are followed by Sticholotidinae (18.00%) and Chilocorinae (12.5%). Coccidulinae is the smallest subfamily with 23 species (5.75%). In the present investigation, author studied only four subfamilies: Scymninae, Coccinellinae, Sticholotidinae and Chilocorinae.

Subfamily: Sticholotidinae

The most primitive group in the family Coccinellidae is the subfamily Sticholotidinae. The characteristic features of the members of this subfamily are the conical or elongate oval apical segment of the maxillary palpi and the narrow junction between mentum and submentum. The tribes of this subfamily includes Sukunahi-konini, Sticholotidini, Plotini, Seranagini and Shirozuellini. Fifteen genera and 72 species are present in this subfamily. Sticholotidini is the largest tribe with 59 species under six genera.

Out of the thirteen species of *Jauravia* reported from India in the tribe Sticholotidini, three species, *viz.*, *J. soror*, *J. dorsalis* and *J. pallidula* were collected in the present study. Among the three species, *J. soror* was the predominant one and was studied for its taxonomic characters. Kapur (1946) reported this as the commonest species of the genus *Jauravia*. It is characterised by small size, pubescent body and coarse punctation with a white hair arising from each puncta. *J. soror* was redescribed by Bhaskar (1992) from Karnataka. In the present study it was collected from cowpea fields feeding on *A. craccivora*. The same species was earlier recorded on mealybug infested sandal trees from

Bangalore (Puttarudriah and Channabasavanna, 1955) and *A. craccivora* from Kerala (Sheena,2003).

J. dorsalis and *J. pallidula* were collected from coccinia, feeding on *A. gossypii*. These are new records from Kerala. These were earlier reported from Karnataka and Tamil Nadu (Puttarudriah and Channabasavanna1955; Poorani, 2002).

Subfamily: Coccinellinae

It is the second largest subfamily of Coccinellidae, which includes 118 species in 31 genera and four tribes. The characteristic feature of this subfamily is eleven segmented antenna and terminal segment of maxillary palpi which is broadened apically and securiform. The four tribes of this subfamily are: Bulaeini, Coccinellini, Psylloborini and Singhikaliini. Coccinellini is the largest tribe of this subfamily comprising of 107 species in 24 genera from India. Author studied only five species under five genera of this tribe: *Coccinella transversalis, Cheilomenes sexmaculata, Harmonia octomaculata, Micraspis discolor* and *Anegleis cardoni*.

Genus *Cheilomenes* was erected by Dejean (1836) and was later renamed as *Menochilus* (Timberlake, 1943) and is now reverted back to the original name *Cheilomenes*. Only one species viz., *C. sexmaculata* is recorded from India in this genus so far. It is characterised by halfmoon shaped marking which is connected with posterior marginal stripe on the pronotum. Seven morphotypes were recorded from Pakistan (Azim and Ahmed, 1966) and four from Karnataka (Bhaskar, 1992).Now four morphotypes are collected from this region.

Genus *Coccinella* was originally described by Linnaeus (1758) and the generic name still exists. Though 12 species were reported from this genus in India, only one species, *C. transversalis* was collected from this region. It was earlier described by Thunberg (1781) as *Coccinella repanda* and has been synonymised by Mulsant (1850) and was revised by Pope (1987).

Genus *Harmonia* was described by Mulsant (1846). Seven species of this genus are reported from India. Only one representative of this genus, *H. octomaculata* is studied from Kerala. This species is characterised by reddish brown elytra with variable number of black spots and broadly V- shaped spermatheca. It was described as *Coccinella octomaculata* by Fabricius (1781), *Coccinella arcuata* by Fabricius (1787) and *H. octomaculata* by Mader (1932) and Sasaji (1971) and was revised by Pope (1989).

Genus *Micraspis* was originally described by Dejean (1836). Among the six species of this genus reported from India, only one species, *M. discolor* was observed in the present study. It is distinguished by a pair of discal spots on pronotum and narrow basal black markings. Fabricius (1798) described this species as *Coccinella discolor*. Mulsant (1850) described it as *Verania discolor* and now it has been renamed as *M. discolor* Sasaji (1968).

Genus *Anegleis* was erected by Iablokoff-Khnzorian (1982). Only one species *A. cardoni* is known from India. It was collected from this region also. It is characterised by two J- shaped black stripes on each elytra. This species was originally described as *Verania cardoni* by Weise (1892) and now renamed as *A. cardoni* (Iablokoff-Khnzorian, 1982).

Cheilomenes sexmaculata was found feeding on *A. craccivora* on cowpea, *A. gossypii* on bhindi and bittergourd and was also collected from rice fields. It was earlier found associated with *A. gossypii* on chilly (Kumar, 1999) and *A. craccivora* on cowpea from Kerala (Joseph, 1990; Rani, 1995; Sheena, 2003) and *N. lugens* in Mandya (Manjunath, 1979) and on aphids, *viz.*, *Brevicoryne brassicae* and *M. persicae* from cabbage fields of Karnataka (Bhaskar & Viraktamath, 2002b)

Coccinella transversalis was collected from *A. craccivora* on cowpea, *A. gossypii* on bittergourd and also from rice. It has been recorded from *N. lugens* on rice at Cuttack (Samal and Misra, 1982), on *A. craccivora* from Kerala (Rani, 1995;Sheena, 2003) and on *Rhopalosiphum* sp. and *Sitobion avenae* in wheat fields (Chander, 1996).

During the course of study, *A. cardoni* was recorded only on *A. craccivora* in cowpea whereas *M. discolor* was collected from rice and cowpea. It was earlier reported from *A. gossypii* on brinjal and on *A. craccivora* on lathyrus, lentil and chickpea (Sharma, 1991) and on *N. lugens* on rice from Cuttack (Samal and Misra, 1995) and from Kerala (Ambikadevi *et a.l*, 1998; Bhaskar, 1999; Beevi *et al*, 2000).

Harmonia octomaculata is found to feed on *A. craccivora* on cowpea and also from rice fields. It has been reported as a biocontrol agent of *N. lugens* on rice (Abraham *et al*, 1973Mancharan and Jayaraj, 1979). It was also reported as a predator of *Baliothrips biformis* (Mammen and Nair,1977) and *A. craccivora* (Joseph, 1990) from Kerala.

Subfamily: Chilocorinae

Subfamily Chilocorinae includes three tribes: Chilocorini, Platynaspini and Telsimini. Distinguishing characters of this subfamily are: antennae usually reduced in length and number of segments and terminal segment of maxillary palpi nearly parallel sided, never strongly divergent apically. Fifty species in 13 genera are included in this subfamily from India. Among the three tribes Chilocorini is the largest tribe with 31 species in nine genera.

Only one species, namely, *Brumoides suturalis* (Fabricius) belonging to the tribe Chilocorini was collected in the present study from cowpea aphid, *A. craccivora*. It has been recorded from Karnataka as *Brumus suturalis* (Fabricius) on brinjal mealybug, *Phenacoccus insolitus* Green (Puttarudriah and Channabasavanna, 1953) and on *C. insolitus* on red gram from Karnataka (Bhaskar & Viraktamath, 2001a). It was also reported on cowpea aphid in oriental region (Agarwala and Ghosh, 1988) and on the same prey from Kerala (Sheena, 2003).

Subfamily: Scymninae

Scymninae is the largest subfamily in Coccinellidae with 137 species in 15 genera, which contributes to 34.25 per cent of the total fauna. The major

characters of Scymninae are small sized body, broad articulation of mentum with submentum and narrow and short elytral epipleura. This subfamily includes five tribes, viz., Aspidimerini, Scymnini, Stethorini, Ortalini and Hyperaspini.

Scymnini is the largest tribe in this subfamily, consisting of 86 species in eight genera. The present study includes representatives of two tribes, Scymnini and Aspidimerini. Scymnini can be easily differentiated by the ten segmented non-geniculate antennae and the first visible abdominal sternite not dilated posteriorly whereas Aspidimerini by the nine segmented geniculate antennae and first visible abdominal sternite dilated posteriorly in an arc in the middle.

In the tribe Scymnini, five species were studied in the present investigation. They are: *Scymnus (Pullus) coccivora*, *S. (P.) pyrocheilus* , *S. (P.) latemaculatus*, *Scymnus (Scymnus) nubilus* and *Pseudoscymnus* sp. The genus *Scymnus* includes four distinct subgenera, of which two subgenera were studied namely, *S. (Scymnus)* and *S. (Pullus)*. Incomplete femoral line is characteristic to *S. (Scymnus)* whereas it is complete in *S. (Pullus)*.

The taxonomic description of three species has been included in this work. *S. (P.) pyrocheilus* can be easily distinguished by its black body which is pubescent and having marginal orange patch. Sipho is having finger shaped projection at basal area and thread like process at apex. The taxonomic descriptions of the species available till date are in foreign languages. The author has described the species in this work.

S. (P.) latemaculatus is also hairy with elytra black and two nearly rectangular orange patches on the dorsal aspect of elytra, similar to *Sticholotis* sp. Sipho is having a small notch near the middle. *Scymnus quadrillum* described by Kapur has been later synonymised with *S. (P.) latemaculatus* (Pope,1989).

S. (P.) coccivora is brownish orange, with dark brown patches on the elytra and outer process of siphonal capsule is broader and longer than inner

process.This species was orginally described by Ayyar (1925) as *Scymnus coccivora.*

S. (P.) coccivora and *Pseudoscymnus* sp. were recorded on mealybugs of brinal during the study. It was first recorded on neem scale, *Chloropulvinaria maxima* (Ayyar, 1925) and later it was recorded from Hibiscus mealy bugs, *Maconellicoccus hirsutus* on grapevine (Mani, 1986). However, *S. (P.) coccivora* and *Pseudoscymnus* sp. are new records from this region of India.

S. (P.) pyrocheilus, S. (P.) latemaculatus and *S. (S.) nubilus* were recorded from *A. gossypii* on bittergourd and coccinia and *A. craccivora* on cowpea respectively. *S. nubilus* was reported to feed on *Pseudococcus saccharifolia* (Mohammed, 1963). Agarwala and Ghosh (1988) reported *S. (P.) pyrocheilus* and *S. (P.) latemaculatus* as aphidophagous coccinellids feeding on *A. craccivora.* These were reported as predators of banana aphid, *P. nigronervosa* from Kerala (Padmalatha *et al.*, 1998), whereas it is the first report on other preys, *viz.* , *A. gossypii* and *A. craccivora* from this region.

Pseudaspidimerus trinotatus and *Cryptogonus orbiculus* are the two species recorded by the author in the tribe Aspidimerini. Genus *Pseudaspidimerus* was described by Kapur (1948c) with the type species: *P. trinotatus* [=*P. circumflexa* (Motchulsky)]. The distinguishing feature of this species is the swollen siphonal capsule, not forming a bulb. *P. trinotatus* is often confused with *C. orbiculus* since they resemble in the dorsal view. *P. trinotatus* is not having any black marks as seen in different morphotypes of *P. circumflexa* as earlier described by Kapur (1948c).

In the present study, *P. trinotatus* was seen in association with *A. craccivora* on cowpea, *A. gossypii* on bittergourd and coccinia and *C. insolitus* on brinjal. It was earlier reported as a predator of *A. craccivora* (Agarwala and Ghosh, 1988) and *P. nigronervosa* (Padmalatha *et al.*, 1998). *C. orbiculus* is now recorded from *A. craccivora* which was earlier reported on *Myzus persicae* (Das and Raychaudhary, 1983). *A. gossypii* and *C. insolitus* are new prey records of *P. trinotatus* from Kerala.

Out of the total 400 species recorded in India, only 16 species were collected from this region, from rice and vegetable crops. Considering the diversity of the flora of Kerala, there is wide scope for studying the coccinellid fauna of Kerala. With the information on prey records of these predators, we can develop newer pest management strategies incorporating the predatory coccinellid beetles. In many crop fields the predatory coccinellids occur abundantly, especially in association with various sucking pests effecting natural control. Conservation of these predators in our crop fields thus enhances the rate of natural biological control. This involves modification of environment condusive to the natural enemies. Minimal disruption to these predators could be obtained by reduction in pesticide use, selective use of pest resistant varieties and changes in cultural practices including the maintenance of refugia for these natural enemies by using strip planting, field borders or cover crops.

Correct identity of coccinellid predators associated with major pests in any ecosystem along with the availability of standard mass rearing techniques help us to exploit their potential as biocontrol agent in managing the pest.

Summary

6. SUMMARY

The present study "Taxonomy of predatory coccinellid beetles (Coleoptera:Coccinellidae) in rice and vegetable crops" was conducted at College of Horticulture, Vellanikkara, during the period 2001-2003.

Coccinellids are abundant in our crop fields, effecting natural control of various injurious pests. They are potential candidates in any biological control programme of key pests for which systematic survey to study the fauna of coccinellids in our crop plants has to be made.

The family Coccinellidae consists of six subfamilies of which only one subfamily Epilachninae is phytophagous. Among the other five subfamilies, Scymninae is the largest subfamily followed by Coccinellinae, Sticholotidinae, Chilocorinae and Coccidulinae.

Taxonomy, species composition and diversity of coccinellid predators in rice and vegetable fields were studied and an up to date key to the identification of these coccinellid beetles was prepared.

A total of sixteen species of coccinellids were collected from rice, cowpea, bitter gourd, coccinia, bhendi and brinjal.In cowpea fields,associated with the aphid *A. craccivora* ten species of coccinellids were recorded, while five species of coccinellids were collected from rice fields surveyed, four species were found to be predaceous in bitter gourd and coccinia fields. Predating the mealybug, *C. insolitus* in brinjal,three species of coccinellids were found.On aphids in bhendi, only one species was reported.

Taxonomic studies were carried out on eleven species in nine genera, in four tribes belonging to four subfamilies namely Scymninae, Coccinellinae, Sticholotidinae and Chilocorinae. The eleven species studied were: *Jauravia soror* of the subfamily Sticholotidinae, *Coccinella transversalis*, *Cheilomenes* [illegible] *discolor*, *Harmonia octomaculata* and *Anegleis cardoni* of [illegible] Chilocorinae and *Scymnus* and *Pseudoscymnus* sp. of Scymninae are new records from Kerala. The aphid, *A. gossypii* is a new prey record to *J. dorsalis* and *J. pallidula*. *S. (P.) pyrocheilus* and

S. (P.) latemaculatus are reported for the first time from *A. gossypii* and *A. craccivora*. *A. gossypii* and *C. insolitus* are new prey reports for the predator, *P. trinotatus* from Kerala.

A key for distinguishing all the species studied have been prepared and taxonomic characters of these species were illustrated in detail.

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TAXONOMY OF PREDATORY COCCINELLID BEETLES (COCCINELLIDAE: COLEOPTERA) IN RICE AND VEGETABLES

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ABSTRACT OF THE THESIS

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2003

ABSTRACT

Members of the family Coccinellidae, commonly called as lady bird beetles and are predatory on a wide variety of pests. The grubs and adults of the beetle are voracious feeders of many sucking pests and effect natural control of pests in our crop fields. The diversity and abundance of predatory coccinellids in field crops are very much dependent on species and number of prey available.

The present investigation entitled "Taxonomy of predatory coccinellid beetles (Coccinellidae : Coleoptera) in rice and vegetables was undertaken to study the taxonomy, species composition and diversity of coccinellid predators in rice and vegetable fields of Vellanikkara and to develop an up to date key for identifying them. Survey was conducted at vegetable fields of College of Horticulture and farmers fields, Vellanikkara and rice fields at Agricultural Research Station, Mannuthy.

From the various fields surveyed, sixteen species of coccinellids were collected. Associated with the aphid, *Aphis craccivora*, ten species of coccinellids were recorded from cowpea fields. Four species of coccinellids each were reported from coccinia and bittergourd fields. In brinjal, three species of coccinellids were recorded on mealy bug *C. insolitus*. Only one species was recorded in bhindi feeding on *Aphis gossypii*. They were included in four subfamilies, viz., Sticholotidinae, Coccinellinae, Chilocorinae and Scymninae in five tribes and ten genera. Taxonomic characters of 11 species collected were studied, namely, *Jauravia soror* of the subfamily Sticholotidinae, *Coccinella transversalis*, *Cheilomenes sexmaculata*, *Micraspis discolor*, *Harmonia octomaculata* and *Anegleis cardoni* of the subfamily Coccinellinae, *Brumoides suturalis* of Chilocorinae and *Scymnus (Pullus) coccivora*, *S. (P) pyrocheilus*, *S. (P) latemaculatus* and *Pseudaspidimerus trinolatus* of the subfamily Scymninae.

A detailed key for all the species studied is prepared by the author. *J. dorsalis* and *J. pallidula* of tribe Sticholotidinae, *S. (P.) coccivora* and *Pseudoscymnus* sp. of Scymninae are new records from Kerala. The present study has also revealed new prey records from Kerala: *S. (P.) pyrocheilus* and *S.(P.)*

latemaculatus on *A. gossypii* and *A. craccivora; J. dorsalis, J. pallidula.* on *A. gossypii; P. trinotatus* on *C. insolitus* and *A. gossypii*.

Of the total 400 species of coccinellids reported from India only 16 species were recorded in the present study from rice and vegetable fields. With the diverse flora and fauna characteristic to Kerala, there is wider scope to explore the species diversity of coccinellids in this region.